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# THE SPONGES OF WOODS HOLE AND ADJACENT WATERS

BY M. W. DE LAUBENFELS

WITH THREE PLATES

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No. 1.—*The Sponges of Woods Hole and Adjacent Waters*

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## INTRODUCTION

The purpose of this article is not only a matter of general record, but also, in some measure, expressly to serve the needs of biologists who are studying in the vicinity of Woods Hole, Massachusetts. About a dozen species of sponge are already known to occur there, and these require emphasis. Other species have been recorded from the North Atlantic seacoast, and almost any of these may be expected to occur, sooner or later, at Woods Hole, wherefore some reference is also made to them here. In both cases, however, attention is given to those from depths less than 100 meters, rather than to those that occur only at greater profundity.

In pursuance of this purpose, there are two parts to the treatment employed: First, an account, with detailed descriptions, illustrations, and a key to the known and highly probable species of Woods Hole itself. Second, an annotated review of the literature references to sponge occurrences from Newfoundland at the north to the Carolinas at the south.

The author has studied the sponges of Woods Hole in the field at various times, from 1924 to 1946. A collection, upon which descriptions are here based, was made in 1946 by Dr. D. H. Zinn, who was at that time naturalist in charge of collecting there. This collection is deposited in the Museum of Comparative Zoölogy.

## METHODS

A sponge specimen should be studied, if possible, while still alive, with record of its color and appearance then. This has seldom been done in the past, but it is to be hoped that future descriptions will include such data.

Sponges should be preserved by being plunged rapidly into 95% alcohol. After a few hours they should be lifted out, the dirty alcohol (with sea water precipitates and organic solutions) should be removed, the jar rinsed, and the specimen replaced in fresh alcohol; this time it can be 70%. If alcohol is not available, the specimen should be rapidly dried. Under no circumstances should formalin be used as it has an unexplained but disastrous effect upon many sponges, inducing maceration.

The specimen should be further studied with hand lens, or better—with the dissecting microscope. One looks for the following items:

Shape. Size. Color. Consistency.

Surface shape, oscules and pores.

Ectosome anatomy, such as presence of cortex, of extensive subdermal spaces, or any other dermal specialization.

Endosome anatomy, especially fibers (if any) and placement of spicules.

Skeleton. This is extremely important, so that much attention must be given to it.

Slices may be cut by hand from alcohol hardened sponge specimens. With a fresh, sharp safety-razor blade these sections can be cut as thin as 50 microns. Such is the cavernous nature of Porifera that only in a few cases (or for special histological study) are thinner sections required. One should have one thin section of the surface (tangential) and a similar one of the lining of the cloaca if such a cavity is present. One should have two or three sections perpendicular to, but including the surface.

Leave the sections lying on the slide (or slides) and apply reagents with medicine droppers, then remove each reagent with absorbent (tissue) paper. These reagents should be used:

1. Safranin in 95% alcohol.
2. Carbol-xylene (Perhaps repeat this).
3. Xylene.
4. Balsam, if a permanent mount is desired.

Apply a cover slip and study with the compound microscope. In xylene or balsam, if the slide is thoroughly cleared (dehydrated) the spicules *and their placement* should be evident.

Calcareous spicules may be recognized by the fact that some or most of them are smooth triaxons (three rays from a central point). If proof is needed, one may use HC1, in which calcareous spicules dissolve but siliceous ones do not.

## GLOSSARY OF TERMS

acantho: a prefix meaning spiny, or thorny.
aniso: a prefix meaning unequally ended (or otherwise unequal).
chela: a type of microsclere; see figure 1A.
anatriaene: a tetraxon spicule with clads curved back toward the rhabd, like grapnels.
bipocilli: a type of microsclere; see figure 1C.
centrotylote: with a central, ball-shaped swelling.
clads: when a polyaxon spicule has one ray distinctly different from the others, that one is called the *rhabd* and the others are called *clads.*
euaster: a star-shaped spicule with no centrum.
iso: a prefix meaning equi-ended (or otherwise equal).
megascelere: a spicule that plays a large part in the structure of the sponge skeleton, or one that resembles those that ordinarily so function.
microsclere: a spicule that is either relatively small, or else is distinctly different from those that are regarded as being megascleres; microscleres never play a large part in the framework of the sponge.
monaxon: an unbranched spicule.
orthotriaene: a tetraxon spicule with clads perpendicular to the rhabd.
oxea: a monaxon spicule that is sharp pointed at both ends.
plagiotriaene: an orthotriaene with very thick clads.
protriaene: a tetraxon spicule with clads bent away from the rhabd, as in a pitchfork.
raphide: a straight monaxon microsclere.
rhabd: see the preceding definition of a *clad.*
spheraster: a star-shaped spicule with a spherical centrum from which the branches radiate.
spiraster: a spiral monaxon microsclere that is acanthose.
sigma: spiral, or "S", or "C" shaped spicules.
strongyle: a monaxon spicule rounded at both ends.
style: a monaxon spicule rounded at one end, sharp-pointed at the other.

tetraxon: a spicule that consists of four rays diverging from a common center.

toxa: a microsclere shaped like an archer's bow.

triaxon: a spicule that consists of three rays diverging from a common center.

tylo: a prefix indicating a rounded or ball-shaped structure; see the following for example.

tylostyle: a monaxon spicule sharp-pointed at one end, but with the other end swollen or ball-shaped.

From the following table and other data one may note the following distributional relationships:

1. Woods Hole species that are primarily northern, being thus near their southern limit, include:

*Haliclona oculata, Halichondria panicea, Scypha lingua* and *Leucosolenia cancellata.* Further south there are many other species of *Haliclona,* but *cancellata* is replaced by *Leucosolenia canariensis.*

2. Woods Hole species that are primarily southern, being thus near their northern limit, include none at all. A sharp faunal separation occurs in New Jersey, where there are few sponges of any kind.

3. Woods Hole species that are distinctive, being common there, but rare both north and south include:

*Haliclona palmata* and *Microciona prolifera.* Of these, *palmata* occurs also in Europe, *prolifera* also in Carolina.

4. *Cliona celata* is common north, south and around the world, as well as at Woods Hole.

5. *Haliclona permollis* is common both north and south of Woods Hole, also around the world, therefore should be expected to occur at Woods Hole. Almost as much may be said of *Hymeniacidon heliophila.*

List of sponges known to occur between Newfoundland and Carolina, at 100 meters depth, or less. The order is that used in de Laubenfels 1936 monograph of the Porifera. Abundance is indicated by +, uncommon occurrence by —. For species numbers 38 and 39, "V" indicates record by Verrill, not Procter.

| | | Also Arctic | Lambe, Newfoundland | Procter, Maine | Sumner, Osburn and Cole, Woods Hole | Zinn Collection, Woods Hole | George and Wilson, Beaufort, N. Car. | Also West Indian |
|---|---|---|---|---|---|---|---|---|
| 1 | *Ircinia fasciculata* | | | | | | − | + |
| 2 | *Aplysilla sulfurea* | | | | | | − | + |
| 3 | *Pleraplysilla latens* | | | | | | − | |
| 4 | *Haliclona permollis* | − | + | + | | | + | − |
| 5 | *Haliclona oculata* | | | + | + | + | | |
| 6 | *Haliclona palmata* | | | | + | + | | |
| 7 | *Isodictya palmata* | | + | − | | | | |
| 8 | *Xytopsues griseum* | | | | | | − | + |
| 9 | *Orina arcoferus* | + | − | | | | | |
| 10 | *Sigmadocia flagellifer* | + | − | | | | | |
| 11 | *Pellina sitiens* | + | + | + | | | | |
| 12 | *Rhizochalina oleracea* | | | | | | − | + |
| 13 | *Iophon nigricans* | | + | + | | | | |
| 14 | *Lissodendoryx isodictyalis* | | | | | | + | + |
| 15 | *Myxilla incrustans* | − | − | − | | | | |
| 16 | *Tedania suctoria* | − | | − | | | | |
| 17 | *Microciona prolifera* | | − | − | + | + | + | |
| 18 | *Mycale lingua* | + | − | − | | | | |
| 19 | *Carmia fibrexilis* | | | | − | | | |
| 20 | *Mycalecarmia ovulum* | | | − | | | | |
| 21 | *Neosperiopsis deichmanni* | | | − | | − | | |
| 22 | *Biemna varianta* | + | − | | | | | |
| 23 | *Calyxabra poa* | | | | | | − | |
| 24 | *Higginsia coralloides* | | | | | | − | + |
| 25 | *Halichondria panicea* | + | + | + | + | + | | |
| 26 | *Cladocroce ventilabrum* | − | | − | | | | |
| 27 | *Hymeniacidon heliophila* | − | | − | | | + | − |
| 28 | *Choanites ficus* | − | − | − | − | | | |
| 29 | *Polymastia robusta* | | − | − | − | | | |
| 30 | *Polymastia andrica* | | − | − | | | | |
| 31 | *Suberitechinus hispidus* | | − | + | | | | |
| 32 | *Suberites domunculus* | | | | | + | | |
| 33 | *Spheciospongia vesparia* | | | | | | − | + |
| 34 | *Cliona celata* | | + | + | + | + | + | |
| 35 | *Topsentia genitrix* | − | | − | | | | |
| 36 | *Craniella crania* | | | | | − | − | |
| 37 | *Grantia canadensis* | | − | | | | | |
| 38 | *Scypha lingua* | − | | V | + | + | | |
| 39 | *Leucosolenia cancellata* | | − | V | + | + | | |

*Key to some of the Species of Sponges already recorded from Woods Hole, or most likely to be found there*

1. Sponges with calcareous spicules. Structure of sponge simple, tubular, or urn-shaped . . . . . 2
   Sponges with siliceous spicules. Structure of sponge more complex . . . . . 3
2. Sponge forming masses of simple cylindrical tubes (Ascon-type). *14. *Leucosolenia cancellata* Verrill (p. 28)
   Sponge developed as urn-shaped bodies, single or several together in clusters . . . . . *13. *Scypha lingua* (Haeckel) (p. 27)
3. Sponge obviously boring, forming narrow channels in calcareous material, musselshells, etc. . . . . *11. *Cliona celata* Grant (p. 23)
   Sponge not boring . . . . . 4
4. Color bright red or violet . . . . . 5
   Color various shades of yellowish brown . . . . . 6
5. Color bright red. *4. *Microciona prolifera* (Ellis & Solander) (p. 12)
   Color violet . . . . . 3. *Haliclona permollis* (Bowerbank) (p. 11)
6. Spicules predominantly simple oxea (with or without other types . . . . . 7
   Spicules predominantly pin-shaped tylostyles with or without other types, or distinctly divided into megascleres and microscleres . . . . . 10
7. Structure of sponge radiate. Spicules simple oxeas and in addition either fork-shaped protriaenes or a few anatriaenes or small S-shaped spirasters . . . . . *12. *Craniella crania* (Müller) (p. 25)
   Structure of sponge not radiate . . . . . 8
8. Encrusting form with a tendency to separate the outer "skin" from the deeper layer. Color more or less orange. Simple oxeas with a great diversity of size. *7. *Halichondria panicea* (Pallas) (p. 17)
   More or less branching forms. Simple oxeas of rather uniform size and forming a network . . . . . 9
9. Colonies of finger-shaped branches, often reaching considerable height. Oxeas medium size. *1. *Haliclona oculata* (Linnaeus) (p. 9)
   Colonies with less tendency to form finger-shaped branches. Oxeas extremely small. *2. *Haliclona palmata* (Ellis & Solander) (p. 10)
10. Megascleres present as styles, microscleres in the form of anisochelas . . . . . 5. *Carmia fibrexilis* (Wilson) (p. 14)

Principal spicules as styles . . . . . 11
11. Styles and peculiar microscleres.
*6. *Neosperiopsis deichmanni* de Laubenfels (p. 15)
Chiefly pin-shaped tylostyles . . . . . 12
12. Surface of sponge covered with tube-shaped fistules, or warty. . 13
Surface smooth . . . . . 14
13. Tube-shaped fistules present on surface.
10. *Polymastia andrica* n. n. (p. 22)
Surface of sponge warty. Color bright yellow.
*11. *Cliona celata* Grant (p. 23)
14. Pin-shaped tylostyles alone. Color yellow or orange.
*9. *Suberites domunculus* (Oliviv) (p. 21)
Pin-shaped tylostyles and minute centrotylote strongyles. Color grayish, possible pink tints.
8. *Choanites ficus* (Pallas) (p. 19)

The ten with asterisks represent those collected by Zinn.

*Systematic Discussion*

## Class DEMOSPONGIAE
1936, p. 6[1]

## Order HAPLOSCLERINA
1936, p. 33

## Family HALICLONIDAE
1936, p. 37

## Genus HALICLONA Grant
1936, p. 38

### 1. Haliclona oculata (Linnaeus)
Fig. 4 and 5

*Spongia oculata* Linnaeus, 1759, p. 1348.

*Specimen described.* No. 6908, M.C.Z.

*Description.* Typically the sponge consists of a short slender stalk which gives rise to many branches, often of greater diameter than the stalk. These branches may occasionally branch again, and now and then form anastomoses. The cross section of the branches may be circular,

[1] The quotation 1936, followed by a page number, refers to de Laubenfels monograph.

oval, or even greatly flattened. Here and there semi-incrusting sponges are found, resembling *oculata* in various respects; it is, however, not clear whether they represent a separate species or not. The typical colonies have branches nearly 10 mm. in diameter, often more than 20 cm. long (smaller individuals have been observed with branches scarcely 5 mm. thick, possibly caused by adverse conditions). The color is dull yellow or yellow-drab. Consistency, spongy and flexible. Surface minutely verrucose. Pores, abundant and minute, but not quite microscopic. Oscules, 1–2 mm. in diameter, about 2 cm. apart, usually without raised rim. Ectosome, notably absent (an important character of the genus *Haliclona*). Endosome, consisting of a rather homogenous ground substance, which under the microscope shows an isodictyal reticulation with spicules that are connected to each other at their ends only, by minute amounts of spongin. Through this ground substance run branching canals, visible to the naked eye, and a loose reticulation of spongin fibers can be traced. The flagellate chambers are, of course, abundantly distributed throughout the entire endosome.

Skeleton: Only one type of spicule is present; it is amazingly constant in size. The normal dimensions are 6 by 120 microns. These spicules are often cemented together by spongin at their tips to make an isodictyal reticulation. Spongin fibers are also present, containing about three rows of embedded spicules. These fibers form likewise an irregular but definite reticulation.

*Type.* Lost.

*Type locality.* European waters.

*Remarks.* Linnaeus' species was made the type species of *Haliclona* by Grant in 1841, p. 5. About twenty years later, Bowerbank changed this name to *Chalina*, and unfortunately many have followed him herein, but the change was quite unjustified.

*Haliclona oculata* is abundant in European waters as well as in those of New England. It is quite possible that specimens from various other parts of the world really represent *oculata*, although they have been assigned to other species. A revision of the entire genus *Haliclona* is urgently needed.

### 2. Haliclona palmata (Ellis & Solander)
### Fig. 6 and 7

*Spongia palmata* Ellis & Solander, 1786, p. 189, pl. 58, fig. 6.

*Specimen described.* No. 6909, M.C.Z.

*Description.* Branching form with a relatively broad base, and small, finger-like branches 3–7 mm. in diameter and 3–7 cm. long.

(All the specimens from Woods Hole examined in this connection have measured less than 3 cm. in height). Color yellowish-drab, like *oculata*, sometimes a more orange shade. Consistency, flexible, spongy, as *oculata*. Surface, similarly verrucose (as in all members of *Haliclona*). Pores, minute, abundant, scattered. Oscules, small, 1–3 mm. in diameter, without raised collars or rims, scattered very irregularly. Ecotosome, absent. Endosome with principally isodictyal reticulation, but with some vague reticulation of spicule-filled fibers.

Skeleton: Spicules differing from other members of *Haliclona* in being of exceptionally small size, measuring 2 by 55 to 3 by 60 microns. In the fibers (which may measure as much as 40 microns in diameter) the core of embedded spicules is often only one third of the total diameter of the fiber, the rest being spongin. *H. palmata* has relatively more fibro-reticulation than *oculata*, and the ground-work of isodictyal mesh is less neatly symmetrical, more irregularly developed.

*Type.* Lost.

*Type locality.* Brighthelmstone, Sussex, England.

*Remarks. H. palmata* has a very similar geographical and ecological distribution to *oculata*. It has, of course, long been treated as a "*Chalina*"; it is now, for the first time, transferred to *Haliclona*.

### 3. Haliclona permollis (Bowerbank)

*Isodictya permollis* Bowerbank, 1866, pp. 273, 278.
*Reniera tubifera* George and Wilson, 1921, p. 145.

*Description.* Typically encrusting, but may grow up into solid, or more often, hollow branches. These latter are apt to be only 5–6 mm. in diameter. The color of a healthy specimen is a very distinctive lavender; obviously dead or dying specimens are dull pale brown, and occasionally one meets apparently healthy specimens of this same shade, but such occurrences are probably pathological. In some specimens green algae are present as symbionts, and in that case the color becomes blue. The consistency is very soft, as indicated by the name. The surface is superficially smooth, though actually minutely irregular. The pores are microscopic and abundant. The oscules are conspicuous, 1–5 mm. in diameter, and usually have raised walls or collars around them. In still water these collars grow very high and thus lead to the hollow tube proliferation mentioned above. The ectosome is notably devoid of specialization; there is no separable dermis, nor extensive subdermal cavity. The endosome consists primarily of an isodictyal

reticulation with only a little spongin, and that confined to the interspicular nodes. Here and there some spicules are aggregated into fascicular tracts that simulate fibers. The spiculation consists of simple oxeas only; these are about 7 by 150 microns long, ranging from 6 by 130 to 8 by 170 microns.

*Type.* Lost.

*Type locality.* Scarsborough, England.

*Remarks.* The species is extremely common in North Carolina, where the author examined numerous specimens in 1946. It is probably worldwide in distribution and thrives in greatest numbers in waters as cool as those of Massachusetts, and in such surroundings it reaches its largest size, much more than in the somewhat warmer water which characterizes North Carolina. Thus it is a dominant coastal species on the Pacific coast of the United States, which has cooler water than the Carolinas. It is therefore preposterous to conclude that it is really absent from the Woods Hole region, and it should certainly be sought with every expectation of discovery at or near that locality.

## Order POECILOSCLERINA
1936, p. 60

## Family MICROCIONIDAE
1936, p. 104

## Genus MICROCIONA Bowerbank
1936, p. 111

### 4. Microciona prolifera (Ellis & Solander)
Fig. 8, 9, and 10

*Spongia prolifera* Ellis & Solander, 1786, p. 189.

*Specimen described.* No. 6907, M.C.Z.

*Description.* Often encrusting, especially when growing intertidally; in that case the colonies may be less than 1 mm. thick though covering areas as large as the human hand. When growing in locations where the colony rarely is exposed to air, lobes may develop, forming elaborate bush-like branches, the more elaborate, the lesser the current. In comparatively quiet waters, at about maximum depth—that is, about 5 meters—a very symmetrical shape replaces the irregular knobby branches. The extreme perfection of the species reached under such

ideal conditions is a finger-sized base from which a large mass of sponge structure is held erect. The sponge mass consists of vertical but thin and wide branches which form a number of rectangular cubicles, open above and below. The walls are less than 1 mm. thick, the diameter of the individual cubicles slightly over 1 cm. and the height of the walls about 1.5 cm. Where lumpy, irregular branches are developed, these may reach a thickness of 4 mm. in diameter and a height of 6 cm.

The color of the sponge is in life a distinctive bright red; dead specimens turn dull pale drab and occasionally such a specimen may be found in the field, perhaps indicating a pathological or even moribund condition. Consistency, tough and elastic. Surface, microscopically hispid. To a keen eye, or by using a hand lens, the sponge may appear to resemble velvet. Pores, microscopic, scattered, abundant. Oscules, small, often difficult to discover. Ectosome with some dermal specialization of the skeleton (see under the latter). Endosome contains many plumose tracts which occasionally branch and anastomose, making a kind of reticulation through the interior of the sponge. These structures may even be called fibers, as they do contain spongin. They are said to be plumose because they bristle with projecting spicules that are situated with the points directed toward the surface of the sponge.

Skeleton: Five different types of spicules are present: (1) thin, typical tylostyles, straight and about 1 by 100 to 5 by 150 microns, occurring chiefly at the surface (erect) or between the fibers; (2) tylostyles, with small heads, so that the greatest diameter of the spicule may exceed that of the head; these spicules constitutes the bulk of the skeleton in all members of this genus, filling the fibers and protruding from them. In the specimen described here, they measure mostly about 7 by 175 microns, but in other specimens they have occasionally been smaller and, more frequently, larger. In the literature an extreme of 16 by 500 microns is recorded, but a length of 9 by 280 is more commonly encountered; (3) acanthostyles, measuring 7 by 90 microns; although rare in *Microciona*, they must be regarded as forming a typical element of the spiculation; it is difficult to assign any particular location to them, but they represent a type which is to be expected as echinating spicules; (4) microscleres, as toxas, ranging from 10–40 microns in length; fairly common in some specimens, while in other cases it is almost impossible to find them; (5) microscleres, as palmate isochelas; these are all close to 15 microns long, and they are likewise sometimes easily found, while in other colonies it may require long and patient search to locate them.

*Type.* Lost.

*Type locality.* East coast of North America, quite conceivably the vicinity of Woods Hole.

*Remarks.* The species is abundant in the New England waters and ranges as far south as the Carolinas. It is known to range, though rare, as far north as Nova Scotia. It can endure brackish water and intertidal conditions extremely well.

## CARMIA Gray
1936, p. 118

### 5. Carmia fibrexilis (Wilson)

*Esperella fibrexilis* Wilson, 1891, p. 511 *nomen nudem*, with brief description on the formation of gemmulae; 1894, pp. 279–337, pls. 14–18.
*Carmia fibrexilis* de Laubenfels, 1936, p. 118 (passim.).

*Description.* Small sponge, 12–15 cm. in diameter, amorphous, flat, encrusting or forming spheroid masses, often with conical processes, acute and very ragged, sometimes these may be combined to form irregular ridges with sharply cut edges. Color yellowish brown. Consistency mediocre. Pores inconspicuous; they are placed over subdermal cavities. Oscules small, abundant. Ectosome, as a thin dermis, almost devoid of spicules, and easily separated from the underlying tissue by subdermal cavities. Endosome, felted, indistinctly reticulated, with few bundles of spicules, placed without order.

Spicules, consisting of (1) megascleres in the form of tylostyles about 250 microns long (in the peripheral region these spicules form radiating bundles, which divide into brushes, supporting the dermal membrane; (2) microscleres, consisting of abundant anisochelas, 30 microns long, rarely 60 microns long, and besides toxas and sigmas, about 100 microns long.

*Type.* Probably lost.

*Type locality.* Woods Hole, growing on wharf piles.

*Distribution.* So far reported from the Woods Hole waters, where Wilson found it abundant.

*Remarks.* The species was amazingly enough not collected by Sumner, Osburn and Cole, who merely refer to Wilson's original paper in 1891, overlooking the larger, more detailed paper from 1894. Neither was it included in Zinn's collection, which has been used as the basis for the present account. It is one of the few species which

has been described from abundant material and in great detail, and an exhaustive account has been given of its gemmules and their development. It should be a species well suited for laboratory work, and with its characteristic dermal layer and few, but characteristic spicules, it should be easy to recognize.

The possibility that this species is identical with Lambe's *Esperella modesta*, now *Mycale babici* de Laubenfels (1936, p. 120) is discussed on p 36. As Wilson's name is the older, the result will not affect his name, *fibrexilis*.

## Family OPHLITASPONGIIDAE
1936, p. 112

### NEOSPERIOPSIS, gen. nov.

This genus is here established to replace *Okadaia* de Laubenfels 1936, p. 120, as this name was preoccupied by Baba in 1930. The diagnosis remains the same. There is a principal reticulate skeleton of monactinal spicules, with distinctive microscleres that resemble sigmas with forked ends; actually these are probably to be regarded as reduced chelas. The closest relationship is to the genus *Esperiopsis*, from which it differs in the shape of the microscleres. The characteristics, other than spiculation, are typical of the family Ophlitaspongiidae, but also resemble sponges of the family Haliclonidae.

The genotype of *Neosperiopsis* is here designated as the following species, *deichmanni*, the holotype to be M.C.Z. No. 6910.

### 6. Neosperiopsis deichmanni spec. nov.
Fig. 11, 12, and 13

*Specimen described.* No. 6910, M.C.Z.; holotype.

*Description.* Massive to lamellate, with digitate projections, resembles in general shape *Haliclona palmata*, while details of its surface resemble those of *H. oculata*. The type measures 10 cm. in height, with four branches, 1–2 cm. in diameter, slightly flattened; the palmate portion is slightly more than 1 cm. thick and 4–5 cm. wide. Color, in alcohol, pale yellowish brown. Consistency, elastic, softly spongy, easily torn. Surface, minutely lumpy, as in *Haliclona*. Pores, visible by the naked eye as minute openings, on small elevations. Oscules, about 2 cm. in diameter, without raised rims; in some places separated by less than 1 cm.'s distance, while other areas, several square

centimeters wide, may lack vents completely. Ectosome, absent; no separable dermis or extensive subdermal cavities. Endosome, finely cavernous, with consistency of the "crumb-of-bread" type.

Skeleton: Spicular tracts are present; the ascending ones measure about 50 microns in diameter, the connecting ones about 30 microns; reticulation not symmetrical or regular; the tracts may or may not contain spongin; if any is present the quantity is small. Spiculation very distinctive. The megascleres are styles, often sharply bent near the rounded end, size 6 by 150 microns. The microscleres are probably reduced chelas, but in shape like sigmas, not contorted, but with each end bifurcated or dichotomously branched; their length (chord) is 21 microns. This type of microsclere characterizes the genus fairly well, as similar spicules are known only in the genera *Strongylacidon*, *Plumocolumella* and *Damoseni*.

*Type*. M.C.Z. No. 6910.

*Type locality*. Woods Hole.

*Remarks*. As already mentioned, the species resembles superficially *Haliclona palmata*, and in the field it has undoubtedly often been passed by, or confused with one of the species of *Haliclona*.

The species that most closely resembles *deichmanni* is *N. quatsinoensis* (Lambe). The latter was described in 1892, p. 69, as *Esperiopsis* from the Pacific Coast of North America (including the other species from the same region, *rigida*, and *vancouveri*, which are straight synonyms of *quatsinoensis*). In general exterior, consistency, surface and interior structure this western form resembles closely the species from Woods Hole, and also the microscleres are extremely similar. The most important difference is that the megascleres are about twice as thick in the Pacific form as they are in *deichmanni*.

Procter in 1933, p. 94, records a species from Maine as *Esperiopsis quatsinoensis* Lambe, and was the first to point out the synonymy of *quatsinoensis* with *vancouveri*, which he refers to, however, as *vancouverensis*, and with Lambe's third Pacific Canadian species, which, however, Procter spells *laxa* instead of *rigida*. Because Procter ignored spicule thickness he was quick to synonymize the Atlantic coast form with that from the Pacific Coast. It may also be true that he had specimens with thick spicules, but it is here considered probable that his Maine specimens had the very thin spicules as found in the Massachusetts species, therefore that Procter's *Neosperiopsis* is also *deichmanni*.

The author, after studying the Woods Hole specimen, obtained a recently collected specimen of Lambe's *quatsinoensis*, U. S. National

Museum No. 2909, collected by K. Holmberg, 25 September, 1947, at Sawak Island, Alaska. Study of this confirms the belief that the Atlantic species is distinct from that of the Pacific Coast.

The specific name is in honor of the eminent marine Zoologist, Elisabeth Deichmann, of Harvard University.

## Family HALICHONDRIIDAE
1936, p. 133

## Genus HALICHONDRIA Fleming
1936, p. 133

### 7. Halichondria panicea (Pallas)
Fig. 14 and 15

*Spongia panicea* Pallas, 1766, p. 388.

*Specimen described.* No. 6906, M.C.Z.

*Description.* Fundamentally encrusting but this shape may be profoundly modified by oscular elevations; the sponge is usually less than 1 cm. thick but spreading laterally indefinitely. Color, basically a rather pale orange, often tinged with green by the presence of algae (probably symbiotic, but not indispensible). As in almost all other sponges, the less it is exposed to sunlight, the paler and duller it is in color. Consistency, compressible, "like a piece of fresh bread." Surface, optically smooth, but not level, with shallow undulations, about 1 mm. from crest to crest. Pores microscopic. Oscules, conspicuous, 1–4 mm. in diameter. The tissues of the sponge are elevated around these vents, so that they resemble craters of tall volcanoes. There is a rough correlation between the speed of currents at the sponge's location and the height of these volcanoes. Where the surf dashes back and forth, *panicca* is nearly smooth, but where it grows in comparative calm, the oscular chimneys may be elevated 2 or even 5 cm. In the latter case the width at the base of the tower is about 1 cm. Ectosome, the members of the genus *Halichondria* are distinguished by having a distinct dermis, which can be detached from the underlying tissue.[1] To a large degree this is equivalent to saying that extensive subdermal cavities are present; these are usually less than 1 mm. in diameter, in vertical direction. In the special dermis, which is about 15 microns thick, many spicules are scattered; almost

[1] There are other sponges which have a similar structure to the members of *Halichondria*, but they can easily be differentiated by their lack of a special dermis.

all of them lie parallel to the skin, otherwise they are arranged without order. Endosome, structure like "crumb-of-bread" which inspired the name of the sponge, with cavernous interior with subspherical hollows.

Skeleton: Only oxeas, but of extremely varying sizes. In the Woods Hole material the average size for the complete spicule is about 9 by 300 microns.[1]

*Type.* Lost.

*Type locality.* The waters around England and Belgium.

*Remarks.* The species was first described from Europe, but it is an abundant intertidal species in almost all parts of the world. It endures exceptionally well the vicissitudes of being exposed at low tide.

## Family HYMENIACIDONIDAE
1936, p. 136

## Genus HYMENIACIDON Bowerbank
1936, p. 137

### Hymeniacidon heliophila (Parker)

*Stylotella heliophila* Parker,[2] 1910, p. 737. Wilson, 1911, p. 13.

*Description.* The species starts as though it should be an encrusting sponge, but soon sends up digitate processes, 2–4 cm. high and less than 1 cm. in diameter, so numerous that they cover practically the entire surface of the colony. The color is a distinctive bright yellow orange. The consistency is mediocre, easily torn, compressible. The surface is comparatively smooth. The pores are abundant, and microscopic. The oscules, 1–5 mm. in diameter, are usually placed at the tips of the digitate processes. The ectosome consists of a thin fleshy dermis. The endosome is spongy, bread-like, almost cavernous. The skeleton consists of great masses of spicules, sometimes aggregated into plumose columns, with the points directed toward the surface, in other cases scattered and packed without order. They consist of styles, ranging from 4 by 120 to 8 by 350 microns, usually 6 by 200 microns.

[1] Brøndsted published, in 1929, an analysis of the spicule length in *Halichondria panicea.* He found that most spicules varied between 168 and 468 microns, with an average of 340, but the commonest size was 372 microns long. The majority of all the spicules were between 324 and 384 microns. Thus the Woods Hole material has spicules which average slightly less than they do in sponges from European waters.

[2] The name of the author needs an explanation. The species was used by G. H. Parker, for some of his classical studies on the primitive nervous system in the lower invertebrates. He gave a description, accompanied by figures, so detailed that the species can be recognized without difficulty. He quoted Wilson as the author, but Wilson's account was not published until the following year; probably Parker was acquainted with Wilson's manuscript.

*Type.* Probably not preserved.

*Type locality.* Beaufort, North Carolina.

*Remarks.* This species is extremely abundant intertidally at Beaufort, North Carolina. A very similar species occurs in the Mediterranean, and is also locally extremely abundant intertidally or in very shallow water. It appears that both north and south of Carolina the intertidal conditions are such that *heliophila* cannot occur in that environment at all. Perhaps the winters are too cold, or the summers too short north of Carolina. There is less clue to the absence south of Carolina. Yet there is a second type of distribution for this species. It can also penetrate into deeper waters, say 5 to 50 meters depth. Under these conditions it does not flourish, but appears as stunted growths of small area, and only widely scattered instead of several colonies per square foot as are often found near Beaufort. On the other hand, in these somewhat deeper waters, utterly unlike the shallow water range, *heliophila* spreads north and south. It is recorded from the West Indies (north of Cuba) by de Laubenfels 1936, p. 138 and from the Arctic (northwest Greenland) by de Laubenfels 1942, p. 265. Because it occurs thus both north and south of Woods Hole, it is included here among the forms to be expected at that region.

## Family CHOANITIDAE
1936, p. 140

## Genus CHOANITES Mantell
1936, p. 143

### 8. Choanites ficus (Pallas)

*Alcyonium ficus* Pallas, 1766, p. 356.

*Suberites compacta* Verrill, 1874, p. 744. Sumner, Osburn and Cole, 1911, p. 558.

*Specimen examined.* U. S. National Museum No. 6352 (Verrill's *S. compacta*).

*Description.* The shape consists of plates and lobes; the size is often that of a human hand. Color, drab or whitish.[1] Consistency, cartilaginous. Surface smooth to the naked eye and to the touch. The

[1] Verrill mentions that the color is yellow, but it is not impossible that he has based his color note on some other species, for example *Suberites domunculus*, a widespread common form which often is bright yellow. The specimen here established as neotype gave indications of having been dull colored—drab or whitish. The members of the genus *Choanites* are often gray, with or without a pinkish tinge.

pores are microscopic, and the oscules small and inconspicuous, often microscopic. Ectosome not developed as a special dermis, although the spicules are packed rather closer together near the surface than they are elsewhere, and those near the surface are somewhat smaller than those of the interior. The endosome is remarkably compact; the larger canals being barely 150 microus in diameter.

Skeleton: The skeleton consists of megascleres which all are tylostyles, some with rather elongate heads. Their sizes range from 9 by 260, to 8 by 330 microns. The microscleres consist of centrotylote strongyles, 20 microns long.

*Type.* Lost; U.S.N.M. No. 6352 here designated as neotype of *compacta.*

*Type locality.* American waters. The neotype came from Vineyard Sound, near Woods Hole, (Albatross).

*Remarks.* The microscleres are characteristic of *Choanites* and never occur in *Suberites.* The name *compacta* Verrill is invalidated by *Halichondria compacta* Lieberkühn, 1859; this species was transferred to *Suberites* in 1900, by Topsent.

## Family SUBERITIDAE
1936, p. 147

## Genus SUBERITES Nardo
1936, p. 147

### 9. Suberites domunculus (Olivi)
Fig. 16, 17, and 18

*Alcyonium domunculum* Olivi, 1782, p. 241.

*Specimen described.* No. 6905, M.C.Z.

*Description.* The sponge forms subspherical masses, often 5 cm. in diameter, sometimes up to 10 cm. Color, typically pale yellow, with or without a pinkish tint added (giving an orange effect) more pigmented on the illuminated side. In preserved condition the color is so pale a gray that it is nearly white. Consistency distinctive, much like that of cork.[1] Surface optically smooth. Pores microscopic, abundant. Oscules, small, and as a rule, inconspicuous. Often the vents are slit-shaped rather than round, even in the living, undisturbed sponge; these slits may measure 0.2 by 2 mm. Ectosome present, with a cortical specialization, approximately 200 microns thick. In this layer the special dermal spicules are densely crowded, perpendicular to the

[1] The generic name *Suberites* refers to the cork-like quality of the sponge.

surface, and pointed outward. Endosome with spicules packed in dense confusion; the soft parts are also dense. There are the usual inhalent and exhalent canals, and flagellate chambers, but these are all small; canals as large as 1 mm. are rare.

Skeleton: Smooth tylostyles which vary greatly in size. Those of the interior of the sponge measure chiefly 9 by 250 microns in the Woods Hole specimen. In other individuals they are often 8 by 320 microns. Special ectosomal spicules, smaller than the endosomal ones, are characteristic of all members of the genus; in *domunculus* these dermal tylostyles range from about 7 by 90 to 8 by 160 microns, usually nearer the smaller size.

*Type.* Probably lost.

*Type locality.* Adriatic Sea.

*Remarks.* The species occurs abundantly, not only in the Mediterranean, but along the shores of Europe and many other regions. When the synonymy of *Suberites* is satisfactorily worked out, *domunculus* will probably be found to be cosmopolitan in its range. It is often found on the shells of mollusks, particularly gastropods, especially where the shell is inhabited by a hermit crab.

### SUBERITECHINUS, gen. nov.

*Diagnosis.* Suberitid, with a skeleton similar to that found in the members of the genus *Suberites*, but with the addition of an ectosomal hispidation of relatively enormous outward-pointing tylostyles.

*Type species. Tethea hispida* Bowerbank, 1864, p. 304.

*Remarks.* The spelling *Tethea* is obviously a misspelling for *Tethya*. The species *hispida* is, however, not a *Tethya*. It is close to *Suberites*, as Lambe observed, but the latter has a cortex of outward-pointing small tylostyles, and no other dermal spicules; in *hispida*, ectosomal outward-pointing tylostyles are also present that are much larger than those of the interior of the sponge. Hentschel, 1929, p. 924, recognized that the species could not be referred to *Suberites*, and transferred it to *Polymastia*, but the latter genus is characterized by peculiar, large, thin-walled fistules which are entirely lacking in *hispida*. Hence the necessity exists for establishing a new genus for this species.

### SUBERITECHINUS HISPIDUS (Bowerbank)

*Tethea hispida* Bowerbank, 1864, p. 404. Verrill, 1874, p. 40, Lambe, 1896, p. 194, pl. 2, figs. 5, 5a–d.

*Description.* Subhemispherical to massive, size of type specimen at least 4 cm. in diameter and less than 2 cm. in height. Color, dull

yellowish. Consistency, compact and firm. Surface, level, extremely hispid, bristling. Pores, microscopic. Oscules usually apically placed, in a shallow depression, diameter about 6 mm. Ectosome, consisting of a cortex, 0.5 mm. thick, packed with small tylostyles as in *Suberites*, and furthermore containing numerous outward-pointing gigantic tylostyles. Endosome, consisting of loose tracts of medium sized tylostyles rising from the base of the sponge to its surface. (Flagellate chambers not examined).

Skeleton: Consists of tylostyles of the following three size-ranges: In the interior, tylostyles 27 by 900 to 1800 microns. In the cortex, smaller tylostyles 2 by 90 to 4 by 180 microns, and larger ones, 20 by 2600 microns.

*Type locality.* Off Portland, Maine, depth not noted.

*Type.* Specimen No. 5 of the Whiteaves Collections in the National Museum of Canada, Ottawa, Canada, is here designated as the neotype of *Tethea hispida* Bowerbank, thus also type of the genus *Suberitechinus*.

*Distribution.* Reported off Sequin Island, Maine, 33 fathoms (Verrill); Portland, Maine (Bowerbank); Casco Bay, Maine, 8–30 fathoms, and St. Lawrence River, near Anticosti, 212 fathoms (Lambe).

*Remarks.* This species may possibly occur also at or near Woods Hole.

## Genus POLYMASTIA Bowerbank
1936, p. 151

### 10. Polymastia andrica nomen nov.
Fig. 19 and 20

*Polymastia mammilaris* Lambe, 1896, p. 196, pl. 3, fig. 1.
Nec *Spongia mammilaris* O. F. Müller, 1776.

*Description.* Subspherical with processes. Type, 4 cm. in diameter. Color, not mentioned, but pale. Consistency, not mentioned, possibly of medium softness. Surface, with smooth fistules, but the main body of the sponge is strongly hispid, with a dense plush of enormous projecting spicules. Pores, typical of the genus, with abundant inhalent openings, but restricted to the surface of the elevated fistules. In *andrica* these are about 15 mm. high. There are 35 such fistules on the type specimen. Oscules, a single oscule in the middle of the fistules (in all Lambe's specimens). In the type the vent is 3.5 mm. broad, on a tube 15 mm. high, 7 mm. wide at its base. Ectosome present as a cortex, but thickness not indicated (in most species of *Polymastia*

this structure is about 1 mm. thick). Endosome, somewhat cavernous. Flagellate chambers, not described.

Skeleton: There are tylostyles of three size ranges, each with its definite location in the sponge. (1) In the main body, 27 by 1500 microns; (2) in the cortex, 13 by 137 to 27 by 750 microns; (3) in the projecting plush, 13–27 by around 5000 microns, often broken.

*Type.* Specimen No. 8 of the Whiteaves collection in the National Museum of Canada, Ottawa, Canada, is here designated as the holotype of *Polymastia andrica.*

*Type locality.* Gulf of St. Lawrence.

*Remarks.* The species is tentatively included in the Woods Hole sponge fauna, on the assumption that some specimens of *Polymastia robusta* Verrill, 1873 (*nec* Bowerbank, 1860, *nec* Lambe, 1896) may be identical with this species. The description here is based on Lambe's "*Polymastia mammilaris*" from Gulf of St. Lawrence. See p. 40. *Polymastia mammillaris* was first described by Müller, 1776, p. 44 as *Spongia m,* transferred to *Polymastia* by Bowerbank, 1862, p. 1104. It has dermal spicules, 3 by 150 microns, endosomal spicules, 8 by 400 microns, only the two categories, and both much smaller than *andrica's.* Sumner, Osburn and Cole list 20 records of Verrill's *robusta* from around Woods Hole. The species *andrica* is set off within its genus by its three distinct spicule types, one of them rendering the surface coarsely hispid.

## Family CLIONIDAE
1936, p. 154

## Genus CLIONA Grant
1936, p. 154

### 11. Cliona celata Grant
Fig. 21 and 22

*Cliona celata* Grant, 1826, p. 79.

*Specimen described.* No. 6904, M.C.Z.

*Description.* The young sponge excavates tunnels in calcareous material. These borings measure about 1 mm. in diameter and are of indefinite length, often over 10 cm. long; they meander and branch occasionally and may perhaps accidentally form anastomoses. At the external opening of each branch, there is typically a protruding papille,

about 1 mm. in diameter and 2–3 mm. high. In brackish water this is as far as *Cliona* develops, while in water of full oceanic salinity the sponge continues to grow.[1] There, at the age of 1–2 years, it emerges from its burrows to make masses of fully exposed sponge. These still have the characteristic papillate surface, reminiscent of the above mentioned protruding papilles. This later, massive stage may attain a diameter and also a height of more than 20 cm. Color, bright, light yellow. Consistency, of medium softness. Surface covered by peculiar papilles 1–5 mm. in diameter, and 2.4 mm. high. They are rounded distally, but the base of each is surrounded by well-defined grooves. Some areas of the sponge (perhaps having been covered by foreign material) may be destitute of the papilles, or they may cover the entire upper surface. Pores, microscopic, and presumably confined to the papilles. Oscules, resembling the pores; in large old individuals there may be some obvious vents up to as much as 10 mm. in diameter. Ectosome, fleshy, less than 50 microns thick. Endosome in young individuals with the spicules scattered without order; in older specimens, they become gradually oriented (parallel) into tracts of semi-fibrous nature; these structures branch and may reach a diameter of 2 mm.

Skeleton: Tylostyles abundant, with comparatively little variation in size; they measure about 10 by 300 microns. It must be mentioned that small spirasters (microscleres) may possibly be demonstrated to occur in this species.[2]

*Type.* Probably lost.

*Type locality.* Firth of Forth, Scotland.

*Remarks.* The species is exceedingly abundant on all the coasts of the oceans of the world, as the famous boring sponge or sulphur sponge.

[1] There are indications that dousing with fresh water (as may occur to intertidal sponges when a rain coincides with a low tide) is fatal to the boring sponge. The author has elsewhere (1947, p. 42) expressed the opinion that the principal survival value of the boring habit of *Cliona* is to escape chemical vicissitudes such as brief exposure to lowered salinity.

[2] Some records of the occurrence of these spicules may possibly refer to the less common form, *Cliona lobata*, which conceivably might be expected to occur at Woods Hole. The megascleres of the latter are, however, 4–5 microns thick, contrasted with a thickness of 8–10 microns which obtains for *celata*. See p. 50.

## Order CHORISTIDA
1936, p. 166

## Family CRANIELLIDAE
1936, p. 173

## Genus CRANIELLA Schmidt
1936, p. 175

### 12. Craniella crania (O. F. Müller)
Fig. 23, 24, and 25

*Alcyonium cranium* O. F. Müller, 1776, p. 255.

*Specimen described.* No. 6903, M.C.Z.

*Description.* The species shows a tendency to be spherical; due to environmental circumstances the final result is always more or less imperfect, though still at least recognizably present. Color, dull yellowish brown. Consistency, firm, cartilaginous. Surface, hispid and felted; thin spicules protrude, sometime so placed as to make a short pile as in plush or velvet. Again these spicules may be so interlaced as to resemble felt, giving a smooth appearance to the surface. Pores, microscopic. Oscules, varying greatly in size, partly due to muscular contractility. In the specimen described here, the oscules are represented, dubiously, by a couple of openings that are less than 1 mm. in diameter. In other specimens the oscules have been observed to measure several mms. in diameter. Ectosome, as a thin cortical layer, less than 20 microns thick, in addition to the above-described felt-like layer of spicules. Endosome with spicules radiating from the center so that they stand almost perpendicular to the surface of the sponge. Each column is packed with spicules running lengthwise, and cemented together by protoplasm, or by colloidal matter with the consistency of protoplasm. Other spicules are strewn between the radiating tracts, and often in some places of these tracts the spicule arrangement is partially broken down into disorder.

The flagellate chamber system is of the rhagon-type, but not well represented by the conventional diagrams of the rhagon pattern, because too much of the sponge's interior is filled by skeleton, while the soft parts are relegated to the interstices.

Skeleton: The megascleres are principally oxeas, about 15 by 1000 to 20 by 2000 microns or even larger. In addition there are a few protriaenes, and still fewer anatriaenes (not illustrated). In these

tetraxon spicules the rhabs are about the size of the oxeas; the three clads of each spicule are only about 50 microns long. The tetraxons occur chiefly in the surface plush, thus are often broken and not recognizable. The microscleres, which are abundantly scattered through the flesh, are sigmoid spirasters, 15 microns long, with a shaft about 2 microns in diameter; they are covered with spines that are much less than 1 micron long.

*Type.* Probably lost.

*Type locality.* Denmark.

*Remarks. Craniella crania* is common in the European waters and has several times been reported from America.

## Class CALCISPONGIAE
1936, p. 192

## Order SYCONOSA
1936, p. 192

## Family SCYPHIDAE
1936, p. 196

## Genus SCYPHA Gray
1936, p. 196

### 13. Scypha lingua (Haeckel)
Fig. 26, 27, and 28

*Sycortis lingua* Haeckel, 1872, p. 278.

*Specimen described.* No. 6902, M.C.Z.

*Description.* Each individual sponge forms a hollow cylinder, somewhat wider at the center than at the ends, and sometimes oval in cross-section rather than perfectly circular. An occasional individual may show branching or budding. Size, usually about 2–3 mm. in diameter and 15–20 mm. in height, up to 5 mm. in diameter, and 400 mm. in height. Color, dingy white, due to reflection of light from the shiny microscopical spicules, with the protoplasm modifying this to a pale dull brown. Consistency, softly fragile. Surface appears smooth, but is microscopically hispid. Pores, frequently closed, present as microscopically small openings, leading into the flagellate chambers (not homologous with the pores found in sponges of the rhagon type).

Oscules apically placed, about half the diameter of the urn-shaped body, often surrounded by a wall 20–30 microns thick and about 1 mm. high, formed chiefly by a palisade of long oxeas, the coronal oxeas. Ectosome, lacking. Endosome, 200–300 microns thick, consisting primarily of flagellate chambers, of the typical sycon-architecture. Each chamber is sack-shaped and about 65 microns in diameter and 200–270 microns long. The large exit opening, which is more than 25 microns in diameter, opens directly into the central hollow of the cylindrical body; this cavity is called the spongocoel or cloaca, and leads to the oscule. Many choanocytes are located on the inner walls of these chambers; in life their flagella can be observed beating inside the chamber. The chambers are situated in respect to the elongate spongocoel much as the bristles of a test-tube cleaner or bottle-brush are placed in respect to the rod which is in the center of such a cleaner. The ramifying space between these chambers corresponds to the inhalent canals of more elaborate sponges, and cross-sections may reveal this space between the chambers in such a way that it seems to resemble inhalent canals. Although homologous with them, this ubiquitous space is not partitioned into distinct canals, and it should therefore not be called by this name.

Skeleton: As usual in sponges, the architecture is outlined by a framework of jelly. In this colloidal mass the amoebocytes wander around, either immersed or crawling on its surface. They are so numerous on the external surface that in fixed stained material they give the misleading impression of being epithelial in nature. In the live sponge they seeth among each other, and do not necessarily touch each other. In the chamber walls lie numerous regular triaxon spicules with rays often 6 microns thick and 100 microns long (various sizes of unfinished spicules occur here, as in all sponges). At the distal end of each chamber there is a bristling tuft or bouquet of oxeas, 10 by 200 to (rarely) 15 by 300 microns. It is on account of these bristling oxeas that the surface is microhispid. The coronal oxeas measure 1–2 mm. in length with a thickness of 20 microns.

*Type.* U. S. National Museum specimen, catalogue number 22727 is hereby designated as neotype of *Scypha lingua*, the original material being lost.

*Type locality.* Newfoundland.

*Remarks.* Woods Hole represents probably the extreme southern range for this species which appears to have its central distribution in the waters around Newfoundland, and has been reported from Fox Basin, near Greenland (de Laubenfels, 1942, p. 267).

The species was originally described as *Sycortis*. The original description was based upon three specimens, sent to Haeckel by a person by the name Taylor. As mentioned elsewhere, it is the species (or possibly one of the sponge species) which supply houses have been selling as *Grantia*, a serious mis-identification.

It is possible that other species of *Scypha* may be discovered to occur in the waters around Woods Hole in addition to *S. lingua*. Most likely to be found are *S. ciliata* and *S. coronata*. The following features should be noted:

The oxeas in the chamber region measure, in *lingua*, 10 by 200 to 15 by 300 microns, in *ciliata*, 6 by 1000 to 11 by 3000 microns, and in *coronata*, 15 by 1000 to 25 by 2000 microns.

The lining of the cloaca or spongocoel contains very few tetraxons in *lingua*, many in *ciliata* and *coronata*.

There may be spicule rays projecting freely into the opening or lumen of the spongocoel. In *lingua* these are uncommon, and when they occur, are straight, about 80 microns long. In *coronata* they are common, and curved, points toward the oscule. In *ciliata* they are also common, and similarly curved, but extremely short—shaped like rose thorns. Such inward-projecting rays have been called "hypogastral" but the spongocoel is not gastric; it is merely an exit passageway. It would be more accurate to call them "hypocloacal."

## Order ASCONOSA
1936, p. 198

## Family LEUCOSOLENIIDAE
1936, p. 200

## Genus LEUCOSOLENIA Bowerbank
1936, p. 200

### 14. Leucosolenia cancellata Verrill
Fig. 29, 30, and 31

*Leucosolenia cancellata* Verrill, 1874, pp. 364, 393.
*Ascortis clarkii* Verrill, 1874, p. 392.

*Specimen described.* No. 6901, M.C.Z.

*Description.* A regular ascon-type sponge, consisting of numerous tubes which occasionally branch. The specimen here described represents a colony of more than a hundred such tubes, growing as close together as possible. The tubes are near to 1 mm. in diameter, and

often slightly over 10 mm. high. Color, dingy white. Consistency, soft, fragile. Surface, distinctly hispid. Pores, microscopic, with numerous openings in the walls of the tubes—homologous with the prosopyles in more highly developed sponges. Oscules, representing the open distal ends of the tubes. Ectosome, absent. Endosome, as a thin wall, less than 50 microns thick, crowded with spicules. As usual there is a colloidal ground substance with amoebocytes immersed in it or crawling on both its surfaces, but particularly the outer one. Choanocytes are crowded on the inner surface, often almost touching each other.

Skeleton: The walls contain numerous triaxon spicules, mostly regular and never strongly sagittal, with rays 3 by 100 to 5 by 120 microns. There are a few small oxeas, about 0.5 by 40 microns. These may be microscleres, but they are so scarce that they are here regarded as juvenile spicules. This is important, because the presence or absence of microscleres is regarded as having considerable taxonomic significance. The lack, or rarity of tetraxons is also noteworthy, as they are abundant in many other members of the genus. Furthermore it is usually true that when tetraxons are lacking, oxeas are also absent.

*Type.* U. S. National Museum specimen, catalogue number 22726 is hereby designated neotype of *Leucosolenia cancellata*, the original material being lost.

*Type locality.* Casco Bay, Maine.

*Remarks.* The species appears to be restricted to the North Atlantic coast. It was originally reported from the Woods Hole region under the name of *botrioides*, but the latter is a species which seems to be restricted to the waters around England, and other parts of the northeastern Atlantic.

Verrill gives no measurements for his spicules, but on p. 392 (under *clarkii*) he states that the fusiform spicules (the oxeas) are $\frac{1}{3}$–$\frac{2}{3}$ the length of the triradiate spicules, and also correspondingly more slender, while in the Woods Hole material the dominating oxeas are much larger than the triaxons. In spite of this discrepancy, it is practically certain that the Woods Hole species is identical with the one described by Verrill from Maine.

## REVIEW OF THE LITERATURE

a. Literature dealing with the sponges of Woods Hole and adjacent waters.

Sponges from the vicinity of Woods Hole doubtless have been studied as early as the eighteenth century, although it may be difficult

to prove this. Thus Ellis & Solander, 1786, p. 189, described *Spongia prolifera* from "America" but the precise location is unknown. The species is now known as *Microciona prolifera*, and represents one of the most conspicuous sponges in Massachusetts.

Probably the first article devoted to sponges especially of this vicinity is that of Rafinesque (or Rafinesque-Schmaltz), 1818, p. 149, "Description of species of Sponges observed on the shores of Long Island." He names as new the following:

1. *Spongia albescens;* smooth, whitish, branched. Quite unrecognizable.
2. *Spongia cespitosa*; rough, yellow, bushy. Possibly *Haliclona oculata* (Linnaeus).
3. *Spongia cladonia*; smooth, fulvous, branched. Quite unrecognizable.
4. *Spongia ostracina*; stupose, red, branched. Clearly *Microciona prolifera* (Ellis & Solander).
5. *Spongia virgata*; smooth, fulvous, almost branched, slender, knobby. Quite unrecognizable.

In 1848 Desor published, "Description of two new Sponges." These New England sponges are:

1. p. 67. *Spongia urceolata*; probably *Microciona prolifera* (Ellis & Solander).
2. p. 68. *Spongia sulphurea*; definitely a *Cliona*, and probably a synonym of *Cliona celata* Grant, 1826.

Haeckel and other European writers described various American sponges as the years went by; thus Haeckel established (1872, p. 278) *Sycortis lingua* now transferred to *Scypha* (see p. 26). But the next publications dealing extensively with New England sponges were due to Verrill.

Professor A. E. Verrill, of Yale, studied the New England sponges for many years, especially in the 1870's. He undertook to name and describe several sponges, doubtlessly motivated by the urgent need to have designations available for animals that could not appropriately be ignored. Yet it is painfully clear that he did not specialize in the Porifera. His descriptions omit details almost as badly as those made by such early premicroscope writers as Rafinesque. A clue to the predicament that was forced upon Verrill is given in this quotation from his excellent article (1873) on the "Invertebrate Animals of Vineyard Sound,"—on p. 743 he comments: "I have no specimens of this and several of the other species at hand, for most of the sponges were sent elsewhere for comparison with named types, and have not

yet been returned." It is probable that they never were returned. In spite of the inadequacies thus forced upon Verrill, his papers are sufficiently important to warrant a detailed review.

In 1871, Verrill, pp. 357–362, in a report dealing with the Woods Hole fauna, includes a reference (p. 359) to *Spongia sulphurea* Desor, mentioned above.

In 1873, Verrill, pp. 435–441, reports on the results of dredgings in deep water near Portland, Maine. The following sponges are recorded, all on p. 440:

1. *Halichondria ventilabrum.* Discussed as *Phakellia ventilabra* (p. 40).

2. A *Trichostemma.* This name falls in synonymy to the older *Radiella,* and it is likely that Verrill's specimen is *Radiella sol,* which is widespread in the deeper parts of the oceans. This easily recognizable sponge is symmetrical, hemispherical, and lies with the more convex side directed downward; a fringe of enormous spicules (more than 70 mm. long) surround the disk, like the ray-flowers of a daisy or a sunflower. The spicules are tylostyles. The species is to be expected only from deep water.

3. *Hyalonema longissimum* M. Sars. The species has later been better reported under the name *Stylocordyla borealis* Lovenby Lambe, 1896, from the Gulf of St. Lawrence. It likewise belongs in deeper water.

4. A small species of *"Holtenia."* This name is now usually dropped into the synonymy of *Pheronema,* but as the spicules were not studied, it is impossible to guess what the species actually was, so the identification is wortbless.

In 1873, pp. 295–778, Verrill published his famous Vineyard report, with a comprehensive ecological survey of the Woods Hole region. In this he lists the sponges which occur in the different types of surroundings. On p. 330 occurs the initiation of an error which has been perpetuated most regrettably. "A small urn-shaped sponge" Verrill opines, is "probably the same" as the *Grantia* of Europe. However, this common sponge from the American waters is a *Scypha,* described as *Sycortis lingua* by Haeckel in 1872 (*Grantia* has a thick, elaborate cortex which is entirely lacking in *Scypha*). As the result of that misidentification, the custom has been established of calling the American *Scypha* by the name of *Grantia* in textbooks, wall charts, commercially prepared microscope slides, and museum specimens.

From the rocky coasts around Woods Hole, Verrill lists:

1. p. 330. *Grantia ciliata.* This has been discussed in the foregoing paragraph.

2. p. 331. *Leucosolenia botryoides* (?). This is now considered identical with *Leucosolenia cancellata* Verrill (see p. 29). Ellis & Solander's *Spongia botryoides*, from the coasts of Great Britain, has so far never been reported with certainty from American waters.

3. p. 331. *Halichondria* sp. This is identical with *Halichondria panicea*.

4. p. 330. *Tedania* sp. This is unrecognizable and almost certainly not a *Tedania*.

5. p. 330. *Reniera* sp. This probably refers to one or more species of the genus *Haliclona*, which are abundant in the Woods Hole region.

From the sandy shores and muddy localities of course no sponges are reported.

From wharves, bridge-piles, and boat-bottoms, Verrill reports the same five species as those he lists from the rocky coast, plus a *Chalina* sp., which undoubtedly represents a growth form of one of the *Haliclonas*. On p. 391 he casually mentions the common red branching sponge; this is certainly *Microciona prolifera*. Also he mentions a slender branching sponge related to *Chalina oculata*. He is doubtless correct in his surmise, but of course the correct designation is *Haliclona oculata*.

From rocky bottom, shallow water, Verrill, p. 409, states that "numerous sponges also occur, but they have not yet been carefully studied." He refers in detail to a sponge which later in the same article he describes as *Chalina arbuscula*. This is probably (but not certainly) *Haliclona palmata*, discussed on p. 10.

For gravelly bottom Verrill gives, p. 420, an excellent account of *Cliona sulphurea* Desor, now *C. celata* Grant.

For sandy bottoms he mentions *Cliona* again (p. 425), and describes a sponge without naming it. It is not at all clear what species is involved.

As might be expected, no sponges are recorded from mud bottom, nor as free swimming, nor as parasites. None are recorded for estuaries, but from brackish water on oyster beds Verrill describes (p. 476) as abundant, the common red sponge (*Microciona*). This ecological location for *Microciona prolifera* is repeated down the coast at least to Beaufort, North Carolina, where the author has found the species in water of less than half the salinity of the open ocean.

For rocky bottom, in deep water, off the coast, Verrill states that sponges are numerous in that environment. He is correct herein, and one might expect up to a hundred species in the Woods Hole region. He mentions (p. 497) that about 12 species were found, "mostly

undetermined." On p. 500 he sums up with *Chalina*, and *Reniera* (*Haliclona*), *Tedania* (unrecognizable) *Cliona*, *Polymastia*, *Leucosolenia* and *Grantia* (*Scypha*).

From sandy and gravelly bottom he stresses the presence of a sponge which he later in the same article (p. 744) describes as *Suberites compacta* (see p. 35).

On pp. 740–745 he gives a catalogue of these species with some additional names. On p. 741 he mentions *Ascortis fragilis* Haeckel, but it is almost certain that none of Verrill's specimens was this European and Arctic species. On p. 742 he mentions *Isodictya*, species undetermined; the species cannot be recognized, and probably it was not an *Isodictya*. On p. 744 he mentions *Halisarca*, likewise species undetermined; this, too, is dubious. Finally he described (p. 744) a new species, *Suberites compacta*. The name is preoccupied and the species is now known as *Choanites ficus* (Pallas) (see p. 19).[1]

In 1874 Verrill published two reports on dredging north of Woods Hole. In the first report (pp. 38–46) he lists, p. 40, without descriptions, the following species:

From off Seguin Island, Maine, 33–46 fathoms: *Tethya hispida*, *Halichondria* spp., *Reniera* sp., and *Grantia ciliata*.

From Casco Bay 8–30 fathoms (p. 44): *Tethya hispida*, *Halichondria pannosa* (undoubtedly a lapsus for *panicea*), *Halichondria* sp., *Reniera* spp., *Cliona* sp., *Isodictya* sp. *I. lobata* (Esper sp.), *I. infundibuliformis*, *Chalina oculata*, *Polymastia robusta* Bowerbank, *P.* no sp., *Grantia ciliata*.

Very little can be said about these names. *Tethya hispida* is discussed on p. 21. *Isodictya lobata* and *I. infundibuliformis* are European species, and belong respectively in *Mycale* and *Tragosia*; there is no indication in Verrill's paper to bear out his identifications, which almost certainly are incorrect, so both species should be omitted from the list of New England sponges.

In the second report, pp. 496–505, he lists, on p. 505, 23 sponges from Cashe's Ledge and Jeffrey's Ledge: *Hyalonema longissimum*, *Dorvillia echinata* n.sp., *Tethya hispida* Bowerbank, *Polymastia robusta* (?), *P. mammilaris* (?), *Trichostemma* sp., *Suberites* (?), *Cliona* sp., *Reniera* spp., *Halichondria panicea*, *H.* sp., *Isodictya infundibuliformis*, *I.* sp., *Grantia ciliata* (*Sycandra* Haeckel), and *G. artica*. Besides he mentions several other sponges not named.

[1] There might be some difficulty in assigning the author for this species. The description appears in a catalogue, pp. 537–778, compiled by Verrill, Smith and Harger, but it is explained in the text who is responsible for the different sections, and Verrill gives his name to the sponges. As *compacta* is a synonym, it is not of great importance. It is mentioned here because Sumner, Osburn and Cole often write "Verrill and Harger," which is not warranted.

Of these species he describes (p. 500) *Dorvillia echinata*, but adds, in a footnote (p. 501), that it possibly is identical with *Thenea muricata* Gray, which Whiteaves had reported with some doubt, from the Gulf of St. Lawrence (see below, p. 41).

In 1874, pp. 340–395, Verrill reports on the exploration of Casco Bay, Maine. Much of the article is an account, in slightly different words, of the material discussed on p. 440 in the shorter article of 1873. He adds, however, three new species:

1. p. 392. *Ascortis clarkii*; abundant in shallow water in Quahog Bay; this seems to be identical with the species that he describes on the following page from Casco Bay, 10–64 fathoms.

2. *Leucosolenia cancellata* (p. 393, name mentioned on p. 360). This name should be retained and it is also undoubtedly the one which should be used for the species known from the Woods Hole region (see p. 28).

3. The third species is *Leucandra cyathus*, p. 392 (briefly mentioned without name on p. 360). It was transferred to the genus *Vosmaeropsis* by Dendy and Row in 1913, p. 756, although neither the two authors nor anybody else could be quite sure of what Verrill had before him. The architecture is stated to be a generalized rhagon-type, and the spicules include all the four types which are common in the Calcispongia in general: monaxons, regular triaxons, sagittal triaxons (T-shaped) and tetraxons, but Verrill gives no spicule sizes. The shape of the sponge is a deep goblet or bell, and this should serve to identify the species, but the generic allocation is quite dubious. It is to be hoped that additional specimens may some day be found in New England, possessing the specifications here given; by further study it should be easy to designate the correct genus. *Vosmaeropsis* is based upon the arrangement of the sagittal triaxons, and the evidence that they are pseudosagittal rather than typically sagittal.

In 1878 Verrill reports, on p. 406, a *Cliona* burrowing in marble; the marble was sunk by a shipwreck, hence the date for the beginning of the boring is known (1871); the galleries tunnelled into the marble during seven years (or less) have penetrated 5 cm. deep or even more.

In 1879 Verrill reports, on pp. 204–205, a new species from off Nova Scotia, 180 fathoms, 43° 17′W., *Cladorhiza grandis*. In 1905 Lundbeck referred this species to the genus *Chondrocladia*, but appropriately commented upon the fact that the species is not well known. Thus Verrill says nothing about the spicules; the description is solely based on the external shape, and it is not accompanied by any figures.

Hyatt described in 1878, p. 163, a new species from New England

(Buzzard's Bay), *Tetilla gravata.* The species is clearly a *Craniella* and almost certainly *Craniella crania,* which is discussed in detail on p. 25.

Probably the most significant publication upon the sponges of Woods Hole that has yet appeared is the one published (1913) in the Bulletin of the Bureau of Fisheries for 1911, "A Biological Survey of the Waters of Woods Hole and Vicinity," by F. B. Sumner, R. C. Osburn and L. J. Cole. They record the following species:

1. p. 556. *Ascortis fragilis* Haeckel. The genus *Ascortis* has long since been regarded as a synonym of *Leucosolenia*; the material belongs probably to *L. cancellata.*

2. p. 556. *Leucosolenia* sp.; "found at several stations." It is not clear how the authors differentiate between these two species. There is one species of *Leucosolenia* known from Woods Hole which in the present paper is considered *L. cancellata* Verrill.

3. p. 556. *Grantia ciliata* Verrill and Smidt. This is obviously the common *Scypha lingua.* The use of the name *Grantia* goes back to Verrill's above-mentioned error. Why the authors attribute *ciliata* as they do is not clear; *ciliata* was established by Fabricius in 1780 for a European sponge. (Throughout the article the reference "Verrill and Smith" occurs repeatedly, clearly indicating Verrill's publication of 1873, already reviewed, in which the species are first established by Verrill, and then summarized by Verrill, Smith and Harger. It would appear that the credit should go either to Verrill alone, which probably is correct, or to Verrill, Smith and Harger).

4. p. 557. *Cliona celata* Grant. Already discussed. Sumner and others make such comments as "abundant, sometimes fills the dredge," and "4 to 35 meters." It is also found intertidally.

5. p. 557. *Polymastia robusta* Bowerbank—"identified with doubt by Verrill and Smith."

6. p. 558. *Suberites compacta* Verrill. This species has already been mentioned in connection with Verrill's 1873 publication, p. 740. The species is here considered synonymous with *Choanites ficus* (Pallas) and described in detail on p. 19.

7. p. 558. *Tethya gravida* Hyatt. In the general description, 1877, p. 34, Hyatt says "about 20 records." It is at present impossible to make out what sponge the various authors have been dealing with. A cosmopolitan sponge, *Tethya aurantia* (Pallas), should be expected at or near Woods Hole. It is a decidedly symmetrical, spherical or ovoid sponge, often reaching the size of a hen's egg, and covered all over with wart-like projections. The color of the sponge is a beautiful golden yellow, except when it is covered by a layer of green algae.

The consistency is firm, cartilaginous. The pores and oscules are small and inconspicuous. The cortex is well developed, fibrous and more than 1 mm. thick. The inner part of the sponge contains radiating fascicular bundles of long spicules, 2–5 mm. long. All the columns arise from a single central point and are approximately perpendicular to the surface, each ends at one of the surface warts. The spicules consist of megascleres in the form of styles with shafts that are largest in the middle instead of at one end, and microscleres consisting of euasters and spherasters, the latter large and often localized near the surface.

8. p. 558. *Halichondria panicea* (Pallas). The authors state correctly that this is one of the most abundant species of the Woods Hole region, adding that it forms irregular pale yellow masses on stems and fronds of algae.

9. p. 558. *Halchondria caduca* Bowerbank. The specimens were identified by Dr. Cushman; they came from various localities in Vineyard Sound and Buzzards Bay. Bowerbank's description reads like a good account of *Halichondria panicea,* and Topsent, 1894, p. 19 has in a careful analysis proved that the two forms are conspecific. It is not clear how the specimens of *caduca* from Massachusetts were differentiated by Dr. Cushman and later by the three authors. Besides this species the authors mention other unidentified *Halichondrias* and *Renieras.*

10. p. 558. *Chalina arbuscula* Verrill. As already noted this is probably, but not certainly, *Haliclona palmata,* discussed on p. 10.

11. p. 558. *Chalina oculata* (Pallas). This is *Haliclona oculata* (Linnaeus). See p. 9.

The authors add further *Chalina* sp. indet., and significantly add: "Dr. Cushman believes that a confusion exists in Verrill's descriptions of the two foregoing species. It is therefore necessary to enter as undetermined all the *Chalinas* taken during the Survey dredgings," also "dried specimens often of large size are to be found in abundance upon the beach at Cuttyhunk Island and elsewhere."

12. p. 559. *Microciona prolifera* (Ellis & Solander). The authors comment that large colonies thrive at the mouth of Wareham River, and in the upper half of Buzzards Bay, and that the species is also widely scattered elsewhere.

13. p. 559. *Esperella modesta* Lambe. A specimen thus identified by Dr. Cushman was taken in Buzzards Bay, near Cuttyhunk, at Fish Hawk Station 7671. This name has been discussed on p. 39 (changed to *Mycale babici* by de Laubenfels 1936). It seems clear that species

related to *Mycale* do occur in New England. The identification of Dr. Cushman's specimen as *babici* is by no means certain on the basis of published accounts. Perhaps it should be referred to the following species.

14. p. 559. *Esperella fibrexilis* Wilson. The authors have only Wilson's first use of the name in 1891, p. 511, where he says that it is abundant near Woods Hole, but gives no description, so it represents a *nomen nudem.* However, in 1894, p. 279, he described the species in great detail, and in 1936, p. 118, de Laubenfels transferred it to the genus *Carmia.* It is here described as *Carmia fibrexilis* on p. 14.

15. *Desmacidon palmata* (Johnston). It appears that Johnston never described a species as *palmata.* He merely referred to *Spongia palmata* of Ellis & Solander, which is a *Haliclona.* As *H. palmata* never has been referred to *Desmacidon,* and no *D. palmata* ever has been described, the present author holds that unwittingly a new species has been described which must be recorded as *Desmacidon palmata* Sumner, Osburn and Cole, 1913, p. 556. Type locality, Crab Ledge, at extreme western end of Vineyard Sound; taken at six stations, in one case the depth was noted as 20–38 meters. The specimens are large and in life dark red in color. This is of course insufficient for recognizing the species, but if the specimens were available, it is by no means certain that they would prove to belong to *Desmacidon.*

The authors comment further (p. 559) on "*?Isodictya* sp." (Verrill, 1873, p. 742) as being perhaps the above-mentioned *Desmacidon.*

In addition the authors list (p. 559) some sponges which Dr. Cushman referred to the genus *Myxilla,* dredged along the western shore of Buzzards Bay at 4 fathoms depth. Not only is the species uncertain, so also is the generic allocation.

b. Review of sponge papers dealing with the region north of Woods Hole.

Whiteaves published, in 1871, 1872 and 1874, three articles dealing with sponges and other marine animals, from the Gulf of St. Lawrence. However, these papers are based chiefly on dredging operations, and give little information about the sponges which have been named in these collections; hence they are not reviewed in detail here. Lambe's papers describe them better.

In 1896 Lambe described a number of sponges from eastern Canada, including those named by Whiteaves. The paper is reviewed here in its entirety, as several sponges belong to both the Woods Hole and the Gulf of St. Lawrence regions, while others may be expected also to be found in the Woods Hole region. Thirty species are considered:

1. p. 182. *Halichondria panicea* Johnson. This sponge is already known to be common in Woods Hole; it is not only found in the Canadian waters, but is practically cosmopolitan.

2. p. 182. *Eumastia sitiens* Schmidt. This species should definitely be expected near Woods Hole. *Eumastia* was reduced in synonymy to *Pellina* by de Laubenfels, 1936, p. 68. The sponge is a mass of thin-walled fistules. The spicules are large oxeas, about 15 by 700 microns.

3. p. 183. *Reniera rufescens* Lambe. This is probably *Haliclona permollis* (Bowerbank).

4. p. 183. *Reniera mollis* Lambe. This requires the same comments as *rufescens*. The members of the genus *Haliclona* are rather generalized sponges, with isodictyal reticulation of small oxeas.

5. p. 184. *Chalina oculata* (Pallas). This is correctly named *Haliclona oculata*. It is known long since as an abundant sponge in the Woods Hole region.

6. p. 184. *Gellius arcoferus* Vosmaer. The species was transferred to the genus *Orina* by de Laubenfels 1936, p. 69. It is an undistinguished sponge with oxeas 19 by 450 microns, sigmas 16 microns long, and toxas 65–175 microns long. It may be expected in deep water near Woods Hole.

7. p. 185. *Gellius flagellifer* Ridley and Dendy. The species has been transferred to *Sigmadocia* by de Laubenfels, 1936, p. 69. It is undistinguished looking sponge, with oxeas 18 by 420 microns long and as microscleres contorted strands 60 to 520 microns long. These are possibly deformed toxas but are more commonly considered deformed sigmas. The species is cosmopolitan. As it has been reported north of Woods Hole by Lambe, and south of Woods Hole by Vosmaer (in the report of the "William Barents" expedition, 1885), it should be expected also at Woods Hole.

8. p. 186. *Desmacella peachii* var. *groenlandica* Fristedt. Burton, 1930, p. 522, has shown that this species is synonymous with *Biemna varianta* (Bowerbank), a species which is abundant in the whole north Atlantic region, European as well as American. It is a sponge of undistinguished exterior, with styles of great size variation, from very small to 30 by 1800 microns. The microscleres likewise vary greatly in size within the same individual; sigmas 8–32 microns, raphides 40–280 microns, and occasionally comma-shaped microscleres, 8–20 microns long.

9. p. 186. *Esperella lingua* Bowerbank. This species was made the type of *Mycale* by Gray, 1867, p. 533. Externally it is characterized by its surface which is imperforate except for the presence of peculiar

grooves and cracks in which the pores are hidden. The oscules also pierce the surface and are quite conspicuous. The spicules are tylostyles, 13 by 530 to 1150 microns. For microscleres there are palmate anisochelas of several sizes (see fig. 1A), also sigmas and raphides. This species is common on both sides of the North Atlantic, and might be likewise expected to occur at Woods Hole (see fig. 1A, below).

10. p. 188. *Esperella modesta* Lambe. This has also been transferred to *Mycale*; it was renamed *M. babici* by de Laubenfels, 1936, p. 120, as the name *modesta* was invalidated by *Esperia modesta* Schmidt, 1862, p. 57. The species was based on a single specimen and is not well known. A species which is fairly well known in the waters around Woods Hole has been referred to Lambe's species (in 1913), but it is not unlikely that the species ultimately will prove to be identical with another Woods Hole species originally described by Wilson (1894). See p. 14.

11. p. 188. *Cladorhiza abyssicola* Sars. This is a bush-shaped sponge with roots. The spicules are long, fusiform styles, sigmas, and peculiar unguiferate anisochelas. It is characteristic of very deep water, chiefly Arctic, and is not likely to be found in the vicinity of Woods Hole.

12. p. 189. *Cladorhiza nordenskioldii* Fristed. Brondsted has shown, in 1914, p. 492, that it is synonymous with *Asbestopluma pennata* (Schmidt). It is an elaborately bush-shaped form, with roots. Smooth styles are present in plumose columns; in the dermis are found acanthostyles, palmate anisochelas, and sigmas. It is characteristic of the very deep water, chiefly Arctic, and is not likely to be taken near Woods Hole.

13. p. 190. *Desmacella palmata* Johnston. Bowerbank made this species the type of the genus *Isodictya*, 1858, p. 197, but the species must be credited to Lamarck, *Spongia palmata*, 1814, p. 452. The species is ramose, externally similar to a well developed *Haliclona oculata*. The spicules are of two types: oxeas, 8 by 200 microns, and distinctive palmate isochelas, 28 microns long (see fig. 1B). The species is moderately common on both sides of the North Atlantic, and is definitely to be expected near Woods Hole.

14. p. 191. *Iophon chelifer* Ridley and Dendy. This is probably *Iophon nigricans*, which was first described as *Halichondria nigricans* by Bowerbank, 1863, p. 767, and made the type of *Iophon* by Gray, 1867, p. 534; it is a common North Atlantic species.

In January, 1948 Dr. Elisabeth Deichmann sent the author *Iophon* material collected from the Portsmouth area of the Gulf of Maine, 16 nautical miles due east of Hampton Beach, 243 fathoms deep. This

material proves to be *Iophon nigricans*. Undoubted *Iophon chelifer* records are confined to South Africa and the Antarctic; the two species are closely related, *nigricans* being the prior name. Ridley and Dendy's species (1886, p. 348) has much smaller anisochelas and differently shaped bipocilli than those of *nigricans*. *Iophon* is definitely to be expected in the Woods Hole vicinity (see fig. 1C, below).

15. p. 191. *Myxilla incrustans* (Johnston). This was described as *Halichondria i.*, 1842, p. 122. It is an undistinguished appearing sponge, with a principal spiculation of acanthostyles 8 by 190 to 15 by 350 microns. There are dermal tylotes 6 by 170 to 10 by 260 microns, with microspined ends. The microscleres include sigmas and anchorate isochelas (illustrated by fig. 1D). The species occurs on both sides of the North Atlantic and might be expected at or near Woods Hole (see fig. 1D, below).

16. p. 192. *Clathria delicata* Lambe. This species which Lambe described as new, appears clearly to be the widespread, well-known *Microciona prolifera*, and is herewith relegated to the synonymy of that species.

17. p. 192. *Phakellia ventilabrum* (Johnston). This should be spelled *ventilabra*, and credited to Linnaeus, 1767, p. 1296 (*Spongia ventilabra*). The sponge is cup-shaped, often 12 cm. high and wide; some individuals are assymmetrical, approaching the fan-shape. The skeleton fibers contain a core of curved, or even several times curved strongyles, often measuring 20 by 1500 microns. These fibers bristle with outward-pointing styles measuring 13 by 440 microns. This species is common in both the eastern and western part of the North and South Atlantic. Verrill, 1873, p. 440, has recorded this species from the New England waters, so it is very likely that it will be found at or near Woods Hole.

18. p. 193. *Suberites ficus* (Johnston). The name is now changed to *Choanites ficus* (Pallas). The species is listed among the Woods Hole sponges. See p. 19.

19. p. 194. *Suberites hispidus* (Bowerbank). The species has been transferred to a new genus *Suberitechinus*.

20. p. 195. *Polymastia robusta* Bowerbank. Verrill (1873, p. 744) has, with some doubt, identified a Woods Hole sponge as *P. robusta*.

21. p. 196. *Polymastia mammilaris* (Müller). Lambe's *mammilaris* is here considered a new species, unique among the other members of the genus in having a strongly hispid body. It is described above as *Polymastia andrica*, n. n. on p. 22.

22. p. 197. *Trichostemma hemisphericum* M. Sars. Burton, 1930,

p. 510, has shown this species to be conspecific with *Radiella sol*, Schmidt, 1870, p. 48. It has been recorded from the West Indies (de Laubenfels, 1936, p. 150) as well as north thereof, but only from very deep water. Verrill reports it from off New England, 1873, p. 440, as a *Trichostemma*, and it might be expected in dredgings from near Woods Hole.

23. p. 198. *Tentorium semisuberites* Schmidt. This is a symmetrical, mushroom-shaped sponge with a few small crater-like oscules on the upper surface. The spicules are only tylostyles, 13 by 270 and 20 by 2400 microns. Verrill reports it from New England (1874, p. 500). It occurs exclusively in very deep water, but it is conceivable that it might occur near Woods Hole.

24. p. 200. *Stylocordyla borealis* Loven. This is a symmetrically built sponge with a spherical body at the summit of a very long slender stalk. Its spicules consist solely of fusiform strongyles. Verrill reports it from the New England waters (1873, p. 440 and 1874, p. 505) as *Hyalonema longissimus* M. Sars, so it might possibly be taken near Woods Hole, but only in very deep water.

25. *Cliona celata* Grant. This is a well known and widespread species which is abundant in the Woods Hole region.

26. p. 202. *Thenea muricata* Bowerbank. This is a symmetrically developed sponge, round, with an equatorial groove between spicular fringes, with rooting tufts of spicules. The spiculation includes oxeas, plagiotriaenes, anatriaenes, and protriaenes as megascleres, with oxyasters and spirasters for microscleres. It has been described from the New England waters as *Dorvillia echinata* by Verrill, 1874, p. 510, and it may possibly be found in very deep water near Woods Hole. (In a footnote, he himself suggests it might be *Thenea muricata* Gray.)

27. p. 203. *Leucosolenia cancellata* Verrill. Lambe's material, from the Gulf of St. Lawrence, differs in only minor respects from the Woods Hole material, which probably represents the southernmost range. Thus his triradiate and quadriradiate spicules have rays which measure about 9 by 130 microns. The type locality was Casco Bay, Maine. See p. 28.

28. p. 204. *Sycon protectum* Lambe. This should be known as *Scypha protecta*, as *Sycon* fell in the synonymy of *Scypha*. Only a few specimens are known, all from the Gulf of St. Lawrence, but they are very distinctive. Dermal triradiates perch around the pores, all three rays placed, or even bent, so as to shield the opening—a quite unique condition; the rays measure 8 by 110 microns. Generalized hypogastral quadriradiates are present, and some oxeas 20 by 1000 microns. There

is a coronal fringe around the oscule, consisting of oxeas 4 by 4000 microns long. It does not seem likely that this species should reach Woods Hole.

29. p. 205. *Sycon asperum* Lambe. This is likewise a *Scypha* and the name was changed to *lambei* by Dendy and Row, 1913, p. 746, as the name *asperum* was twice preoccupied, first by Schmidt, 1862, p. 15, later by Gibson, 1886, p. 364. The species was based on a single specimen and it is here relegated to the synonymy of *Scypha coronata* (Ellis & Solander), an abundant European species. See p. 28, under *Scypha lingua*, where a comparison is given of three species of *Scypha* (*lingua*, *coronata* and *ciliata*).

30. p. 206. *Grantia canadensis* Lambe. The three specimens from the Gulf of St. Lawrence which Lambe examined seem to represent the only authentic occurrence of *Grantia* in North American waters. As stated elsewhere, the genus is common in European waters. The genus differs from *Scypha* in that it has a cortical layer over the entire outside, whereas the flagellate chambers of *Scypha* are naked. *Grantia canadensis* exhibits a highly developed sycon architecture. The principal spicules are triradiate, with rays 200 to 300 microns long (diameter not given). The gastral quadriradiates are of about the same dimensions. In the chamber layer are found oxeas 13 by 700 microns long; around the oscule are found coronal oxeas which are 5 by 1800 microns long. The species has never been reported from the Woods Hole region, but one should be on the watch for it, as it easily may be mistaken for the more plentiful and outwardly similar members of the genus *Scypha*.

In 1900, Transactions of the Royal Society of Canada, Lambe published a second article on the sponges of Canada, but, as he says, this paper consists of identifications or descriptions of sponges found farther to the north, off the coast of Labrador, in Davis Strait and Baffin Bay. In terms of likelihood, it is less to be expected that the forms described in that paper should occur near Woods Hole, unless they are some already discussed in the paper of 1896. It has therefore been deemed unnecessary to review this later paper.

In 1933 William Procter published a "Biological Survey of the Mount Desert Region." This locality is on the coast of Maine, latitude 44° 20′ north, longitude 68° 20′ west. Of this report, pages 78 to 115 are devoted to Porifera, with twenty-six species recorded. The list is confined to so-called Monaxonida, omitting any sponges that belong in the orders Choristida, Carnosa and Keratosa. It is not clear whether Procter would have regarded Epipolasida as "monaxon" or not.

Furthermore, any Calcispongiae of the region are, of course, omitted. The article, most regrettably, gives no illustrations of spicules or sponges. Spicule diameters are consistently omitted, and almost no information is given as to the ectosomal structures, which nowadays are regarded as possessing especial significance. Thus it happens that for some of these Maine sponges it is impossible to tell what species, or even what genus is really represented. On the other hand, it seems clear that an exceptionally thorough study of the region has been made, with few or no species overlooked.

The Mount Desert Island sponge fauna, as reported by Procter, may be summarized as follows:

1. p. 86. *Halichondria panicea* (Pallas). Correctly identified. Abundant in Maine.

2. p. 87. *Halichondria genitrix*. Procter has two specimens which he thus identifies. His description does not guarantee the correctness of the identification, but neither does it contraindicate correctness. The species *genetrix* was described as *Amorphina* by Schmidt, 1870, p. 41, and transferred, correctly, to the genus *Topsentia* by Topsent, 1920, p. 29. This is not close to *Halichondria*, but has a peculiar skeleton of very large oxeas, interspersed with very small ones.

3. p. 87. *Halichondria fibrosa* (Fristedt). Procter comments that his specimen thus identified is much like the preceding. His description reads even more like *Topsentia genitrix* than the preceding does, and it is here suggested that it should also be so identified.

4. p. 88. *Eumastia sitiens* Schmidt. This abundant Maine species appears to be correctly identified as to species. As to genus, however, de Laubenfels, 1936, p. 68, reduced *Eumastia* in synonymy to *Pellina*. This species, *Pellina sitiens*, consists of extremely thin-walled tubes. The skeleton is made of oxeas which are fastened together at their ends by a small amount of spongin in the isodictyal arrangement.

5. p. 88. *Reniera cinerea* (Grant). Procter does not show how his one specimen so identified differs from the following. It is here suggested that it is conspecific with the following.

6. p. 89. *Reniera heterofibrosa* Lundbeck. The abundant Maine species thus identified, on the basis of Procter's description and extreme likelihood as well, is here instead referred to the very abundant, widespread species *Haliclona permollis* (Bowerbank), discussed elsewhere in this article, page 11.

7. p. 90. *Reniera ventilabrum* Fristedt. "Several specimens." The species identification is very probably correct, but Burton, 1930, p. 516, transferred *ventilabrum* to the genus *Cladocroce*. Procter synonymizes

Lundbeck's *Renieras folium, hyalina* and *parenchyma* with *ventilabrum*. It seems clear that Procter is quite correct in this action, therefore it is here further confirmed that these three should be dropped to *Cladocroce ventilabrum*. This species is leaf or vase shaped, with plumose fibers in a ground mass that is an isodictyal reticulation of spicules. The latter are exclusively oxeas.

8. p. 93. *Reniera urceolus* (Rathke and Vahl). Procter mentions "2 beautiful specimens." It would seem from his description that they were either *Haliclona* or *Callyspongias*, but they may belong in yet some other genus. More information is needed.

9. p. 93. *Chalina oculata* (Pallas). This is the common sponge *Haliclona oculata*, discussed in this article on page 9. It appears to be only moderately abundant in Maine.

10. p. 94. *Esperiopsis quatsinoensis* Lambe. Procter records this from two stations. It is clearly a *Neosperiopsis*, almost certainly that which is described as *N. deichmanni* elsewhere in this article (p. 15). A principal difference between *deichmanni* of Woods Hole, and *quatsinoensis*, which is a species of the Pacific Coast of North America, is that *deichmanni* has much thinner spicules. It is therefore regrettable that Procter does not give spicule diameters. The opinion is here nevertheless expressed that the Maine specimens were probably *Neosperiopsis deichmanni*.

11. p. 96. *Esperiopsis* sp. Almost certainly not an *Esperiopsis*. Procter makes frequent allusion to "the peculiar *Homoeodictya* chelae" but gives no figures to show what he has in mind. The spicule type that he refers to, according to him occurs in species that correctly belong in the genera *Neosperiopsis* and *Isodictya*, but these genera have microscleres that differ emphatically. Does he mean *Neosperiopsis* chelas, or does he mean *Isodictya* chelas?

12. p. 97. *Mycale lingua* (Bowerbank). On the basis of Procter's description, his few specimens of this sort are correctly identified. Further notes are given in connection with the following species.

13. *Mycale ovulum* (Schmidt). The few specimens thus designated appear to be correctly identified as to species, but *ovulum* was transferred into the genus *Mycalecarmia* by de Laubenfels, 1936, p. 120. On page 14 of this article there is a description of *Carmia fibrexilis*; three closely related genera may be compared as follows:

*Mycalecarmia* has anisochelas as microscleres.

*Mycale* has anisochelas and sigmas.

*Carmia* has anisochelas, sigmas and toxas.

All three have a principal skeleton of styles in fibers, usually rather

plumose fibers, and notably cavernous structure. They differ chiefly in microsclere content. It is conceivable that they are really congeneric, but it is here suggested that it is well to be cautious about such a conclusion; if the three sorts are discussed under separate headings, one can know which of the three types is involved.

14. p. 99. *Myxilla incrustans* (Johnston). This species is common in Europe and the Arctic, and is recorded by Lambe from Eastern Canada. Although Procter gives inadequate data, the assumption is here made that his identification is correct. The species is uncommon in Maine, but might occur, also uncommonly, as far south as Woods Hole. This is an inconspicuous encrusting sponge, that has somewhat the "bath sponge" look to the naked eye. The ectosomal skeleton consists of smooth tylote spicules. The endosomal skeleton is made of spiny styles arranged—many on a side—about triangular or polygonal spaces. The microscleres comprise sigmas and isochelas. The latter are of the sort termed anchorate in the genus *Myxilla*, but are instead arcuate in the otherwise similar genus *Lissodendoryx*. Procter gives no data as to whether his specimens had arcuate or anchorate chelas. *Lissodendoryx* is abundant to the south of Woods Hole, therefore further comparison is in order. Nearly all specimens of *Lissodendoryx* (say 99 out of 100) have a distinctive, pungent, "sulfureous" odor. This is not mentioned in the literature for *Myxilla* specimens, but neither is its absence recorded. This may or may not be a useful point of comparison, but probably is. The principal spicules of *Myxilla* are always very spiny. Most of them in *Lissodendoryx* are usually quite smooth, but some or all may be more or less spiny. This trait may nevertheless have considerable value in separating the two genera—a specimen with all smooth endosomal spicules would probably not be a *Myxilla* (see fig. 1D, below).

15. p. 100. *Myxilla fimbriata* (Bowerbank). The few specimens so identified by Procter may also be *Myxilla incrustans*, or may be some *Lissodendoryx*. The species *fimbriata* has a peculiar anchorate isochela, and Procter's description does not indicate that his specimens were so provided. This is genus and species incertae sedis.

16. p. 101. *Homocodictya palmata* (Johnston). Only one small specimen was discovered in Maine, but Lambe found this more common a little further north. The correct genus is *Isodictya*; Ehlers, 1870, p. 17 tried to change the earlier name, of which he disapproved, but of course his later name falls in synonymy (see fig. 1C, below).

17. p. 101. *Tedania suctoria* Schmidt. The few specimens so identified seem to be quite correctly placed. This species has a dis-

tinctive warty upper surface, but not the spherical form of the also warty genus *Tethya*. The ectosomal megascleres are smooth tylotes 3 by 250 to 6 by 500 microns, the endosomal megascleres are smooth styles about 7 by 400 microns, chiefly in confusion. The microscleres are rough-surfaced, very thin rhaphides, 50 to 500 microns long. This species should be expected to occur at Woods Hole.

18. p. 102. *Stylotella simplissima* (Bowerbank). The species *simplissima* was described as *Raphiodesma s.* by Bowerbank, 1874, p. 323, and correctly transferred to the genus *Stylinos* by Topsent, 1892, p. 136. Procter's solitary specimen is a crust, where *simplissima* tends to be fan-shaped. The Maine specimen is probably *Hymeniacidon heliophila*, discussed on page 18 of this article. This latter species flourishes amazingly in the intertidal regions about Carolina, but is entirely absent from colder intertidal areas. In deeper water it does not thrive, but does occur, even up to the Arctic.

19. p. 104. *Iophon chelifer* Ridley and Dendy. A sponge that is clearly an *Iophon* is described by Procter as abundant in that part of Maine. In January 1948, Dr. E. Deichmann sent to the author *Iophon* material from the Gulf of Maine, 16 nautical miles due east of Hampton Beach, only some 30 miles north of Procter's stations. This material proves to be the species *Iophon nigricans*, a common sponge in the whole North Atlantic region, first described as *Halichondria n.* by Bowerbank, 1865, p. 767. Sponges that are certainly *Iophon chelifer* are reported only from South Africa, the south Indian Ocean and the Antarctic. They differ from the earlier species *nigricans* only in minor points, especially shape of the bipocilli. Procter does not figure his spicules, but it seems quite evident that he had *nigricans* rather than *chelifer* (see fig. 1C, below).

20. p. 104. *Microciona prolifera* Verrill. Aside from crediting the wrong author, this is obviously a correct identification. This species, so abundant at Woods Hole, and for several hundred miles to the south thereof, was represented by only one small specimen in the Maine collections.

21. p. 106. *Suberites hispidus* (Bowerbank). This species was fairly common in the Maine collections. Elsewhere (p. 21) in this article it is redescribed as *Suberitechinus hispidus*.

22. p. 108. *Suberites montalbidus* Carter. A few specimens found in Maine, and thus identified, are so described as to make it evident that they are really *Choanites ficus*, discussed elsewhere in this article. It is very likely, as Topsent opined in 1900, that Carter's Arctic species (*montalbidus*) may also belong in the species *ficus*.

23. p. 109. *Suberites concinnus* Lambe. Procter thus designates six specimens, using the words "with some doubts." It is impossible to tell, from his description, to what genus or genera these six sponges belonged. It might prove to be equally impossible to identify them if the specimens were available; the opinion is here expressed that they may be abnormal specimens of some other local species.

24. p. 110. *Polymastia robusta* Bowerbank. The few specimens thus designated by Procter are probably correctly identified, although all the *Polymastia robustas* of various authors as found on the west shore of the Atlantic differ slightly in spicule size from those of the east Atlantic.

25. p. 112. *Polymastia* sp.? Procter describes six specimens from his locality without finding a species for them. He had good reason to be puzzled. They clearly belong to that which is in the present article described as *Polymastia andrica* new species.

26. p. 114. *Cliona celata* Grant. This species is correctly identified and evidently is nearly as common in Maine as it is in Massachusetts.

c. Review of sponge papers dealing with the fauna south of Woods Hole, as far south as Beaufort, North Carolina.

In 1921 George and Wilson published (vol. 36 of U. S. Bulletin of Fisheries) an important article on the "Sponges of Beaufort (N. C.) Harbour and Vicinity." Although this locality is less than six hundred miles to the south of Woods Hole, its fauna of Porifera is distinctly different, the affinities being decidedly with the West Indian region. The indications point to a line of demarcation between the two sponge faunas occurring somewhere in the vicinity of New Jersey. What little evidence is available seems to indicate that there may be some kind of a hiatus there, as very few sponges of any kind are reported from the coasts of New Jersey. The paper has nevertheless to be reviewed in its entirety, as in a few cases it is possible that the sponges may also be discovered in the Woods Hole region, while other, widespread species are known from both localities.

The two authors describe 17 species which may be briefly summarized as follows:

1. p. 135. *Spirastrella andrewsii* George and Wilson. This is the common and long known West Indian sponge, much the largest in the world, which is correctly named *Spheciospongia vesparia* (Lamarck). See de Laubenfels, 1932, p. 48 and 1936, p. 140.

2. p. 138. *Cliona celata* Grant. This occurs also in New England, as noted already. It has no value whatsoever in determining faunal territorial relationship, because it is completely ubiquitous. It would

be difficult or impossible to find any marine, shallow water province with calcareous shells of any sort present, where *Cliona* did not occur.

3. p. 138. *Poterion atlantica* George and Wilson. This also is the West Indian *Spheciospongia vesparia.*

4. p. 140. *Suberites undulatus* George and Wilson. The author of the present paper was unable to find this species at Beaufort during his visit in 1946. From the published description it is not at all clear that it was a *Suberites.*

5. p. 142. *Tetilla laminaris* George and Wilson. This is the cosmopolitan *Craniella crania* Müller, which also occurs, not only at Woods Hole, but in many other parts of the world.

6. p. 145. *Reniera tubifera* George and Wilson. This is the cosmopolitan species *Haliclona permollis* (Bowerbank), and is extremely common in the waters of North Carolina. The species has not with certainty been recorded from the Woods Hole region, but it is preposterous to think that it is really absent from Woods Hole. A description of this species has therefore been added to those given of the Woods Hole sponges. (See p. 11).

7. p. 147. *Stylotella heliophila* Wilson. This is *Hymeniacidon heliophila* (Parker). It occurs also in the West Indies and a very similar sponge occurs in warm waters in the Mediterranean. Other species of the genus are common in cool water in the northern part of the European seas. Most remarkable of all in this connection, is that de Laubenfels, 1936, p. 263, recorded *H. heliophila* from Northwest Greenland. Thus there is every reason to anticipate finding the species in the Woods Hole region, and a brief description of this species is therefore given on p. 18.

8. p. 148. *Esperiopsis obliqua* George and Wilson. This is an abnormal specimen of *Microciona prolifera.*

9. p. 150. *Lissodendoryx carolinensis* Wilson. This is really *Lissodendoryx isodictyalis* (Carter), a sponge typical of the West Indies.

10. p. 152. *Phlocodictyon nodosum* George and Wilson. This is really *Rhizochalina oleracea* Schmidt, a sponge that is typical of the West Indies.

11. p. 154. *Phoriospongia osburnensis* George and Wilson. This is really *Xytopsues griscus* (Schmidt). A sponge typical of warm water marine environments. It was first described as *Desmacidon griseum* by Schmidt, 1870, p. 55, from the West Indies, and is here transferred to *Xytopsues.*

12. p. 157. *Microciona prolifera* Verrill. This should actually be credited to Ellis & Solander, not Verrill. It is a well known form, abundant at Woods Hole.

13. p. 159. *Axinella acanthifera* George and Wilson, and

14. p. 161. *Acanthella corrugata* George and Wilson. Neither of the two species could be found as such by the author in 1946. They were based upon specimens which probably were malformations of some sponge or other, perhaps *Microciona prolifera.*

15. p. 163. *Aplysilla longispina* George and Wilson. This species represents *A. sulfurea* Schulze, a sponge that is typical of warm water marine environments. The sponges of the genus are soft, very conulose, with no spicules, but have horny fibers that often branch, but never anastomose, so that they are like miniature leafless trees (dendritic fibers). Some *Aplysillas* favor cold water, especially *A. glacialis* (Merejkowsky). *Aplysillas* should be sought and may perhaps some day be discovered at or near Woods Hole.

16. p. 165. *Pleraplysilla latens* George and Wilson. This appears to be an endemic sponge, not to be expected anywhere else.

17. p. 166. *Hircinia ectofibrosa* George and Wilson. This is *Ircinia fasciculata* (Pallas), a sponge typical of warm water regions.[1]

In 1947 de Laubenfels published an ecological study of the sponge fauna in Beaufort. He reviewed George's and Wilson's earlier paper, corrected the names, and added furthermore three species:

1. p. 36. *Haliclona excelsa* (Schmidt). The identification is made with some reservation. While it seems certain that the Beaufort species is identical with the one which Verrill described as *Pachychalina millepora,* from Bermuda, it is not completely certain that it is identical with the one Schmidt originally described as *Pachychalina excelsa* from the waters of northwestern Europe.

2. p. 36. *Higginsia coralloides* Higgin. A typical West Indian form which is not likely to be expected further north.

3. p. 36. *Calyx poa* de Laubenfels. Described as new, and so far not known from any other locality. The species may possibly deserve a genus of its own. The name *Calyx* is herewith replaced with *Calyxabra* n.n., as it has been discovered that *Calyx* is preoccupied.[2]

In 1941 M. C. Old published a paper that has significant bearings on the Woods Hole sponges. This is an account of the boring sponges,

[1] The type species of the genus *Ircinia* Nardo, 1833 (*Hircinia* Nardo, 1834) must be established as that described by Schmidt, 1862, p. 34, as *Hircinia fasciculata,* actually a redescription of *Spongia fasciculata* Pallas, 1766, p. 381. As Pallas' specimen is lost, United States National Museum specimen No. 22503 is herewith established as the neotype.

[2] Vosmaer established the sponge genus *Calyx* in 1886, with *Spongia nicoensis* Risso, from the Mediterranean, as the type species. Unfortunately, Ronault had named a genus of echinoderms *Calix* in 1851, and Bigsby in 1868, accidentally spelled it *Calyx,* thereby making *Calyx* a synonym of *Calix,* according to the accepted rules of the International Committee on Zoological Nomenclature.

emphasizing *Cliona celata,* which is abundant in Massachusetts waters (see p. 23). The efficient research of Old shows that rarer species of boring sponges can be found through meticulous search.

Old also detected the presence, in the vicinity of Long Island, of *Cliona lobata* Hancock, 1849, p. 341. This species is distinguished from *celata* by the possession of small spirasters. Numerous authors, led by Topsent, 1900, p. 35, believe that these spirasters are normally present in young *Clionas,* and then, equally normally, are lost. Yet Topsent regards *lobata* as a valid species. If *celata* really ever does possess proper spirasters, they are certainly extremely rare, briefly present, and most difficult to find. It may be possible to identify *lobata* by the abundance and persistance of the spirasters. The megascleres of *lobata* are thinner than those of *celata.*

Old likewise reports *Cliona vastifica* Hancock, 1849, p. 342, from the vicinity of Long Island. This, and certain other identifications in the same paper, may be mistaken. *Cliona vastifica* may be confined to the so-called "Old World." It is brownish red in life, rather than yellow, and this color is retained to a considerable extent even in preserved specimens. Its megascleres are very slender, only 4 microns thick. It has an abundance of microscleres that are often called spirasters, but they are peculiar, scarcely more than short, microspined cylinders, 10 microns long.

Old adds an interesting new species to the American fauna. This is *Cliona truitti,* which is characterized by the possession of megascleres (tylostyles) only 2 to 3 by 250 microns, and—in addition to spirasters as in *lobata*—there are distinctive centrotyloteacanthomicroxeas. *Truitti* is recorded from the Long Island region, hence may be expected at Woods Hole.

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PLATES

PLATE 1

## PLATE 1

Different types of more complex sponge spicules

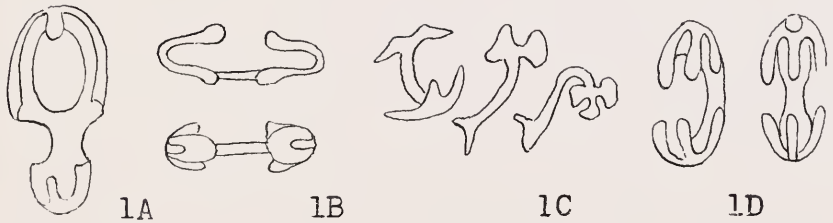
Fig. 1A. Palmate anisochela, as in *Mycale lingua* and *Carmia*.
Fig. 1B. Palmate isochelas, from *Isodictya palmata*, lateral and front view.
Fig. 1C. Bipocilli, as in *Iophon nigricans*.
Fig. 1D. Anchorate isochelas, as in *Myxilla incrustans*.

*Choanites ficus* (p. 19)

Fig. 2. Head of one of the characteristic tylostyles. (x 2000).
Fig. 2A. Three microscleres. (x 2000).

*Suberitechinus hispidus* (Lambe) (p. 21)

Fig. 3. The entire sponge, possibly the type, growing on a barnacle shell. Natural size. Copied from Lambe, plate 2, fig. 5.
Fig. 3A. Typical spicules, tylostyle, from same, copied. (x 272).



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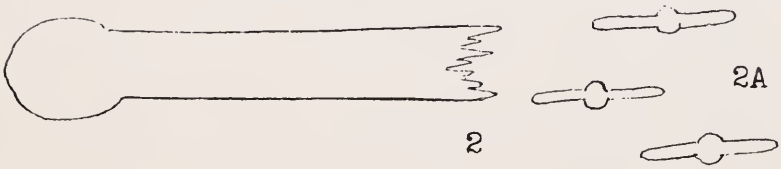

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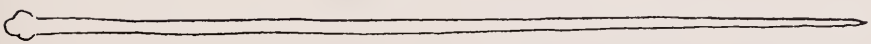

3A

PLATE 2

## PLATE 2

*Haliclona oculata* (p. 9)

Fig. 4. Part of a young specimen from Woods Hole. Natural size.
Fig. 5. Isodictyal reticulation from same. (x 100).

*Haliclona palmata* (p. 10)

Fig. 6. Part of the sponge, from Woods Hole. Natural size.
Fig. 7. Isodictyal reticulation from same. (x 100).

*Microciona prolifera* (p. 12)

Fig. 8. Branch of colony, from Woods Hole. Natural size.
Fig. 9. Megascleres. (x 100).
Fig. 10. Microscleres. (x 100).

*Neosperiopsis dcichmanni* (p. 15)

Fig. 11. Fragment of the type, from Woods Hole. Natural size.
Fig. 12. Megascleres. (x 100).
Fig. 13. Microscleres. (x 1000).

*Halichondria panicea* (p. 17)

Fig. 14. Part of a colony, from Woods Hole. Natural size.
Fig. 15. Spicules. (x 100).

*Suberites domunculus* (p. 20)

Fig. 16. Small colony growing on a gastropod shell; from Woods Hole. (x ½).
Fig. 17. Spicules. (x100).
Fig. 18. Spicules. (x100).

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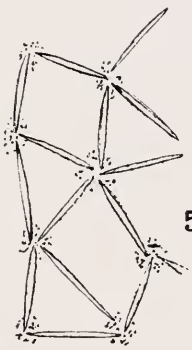
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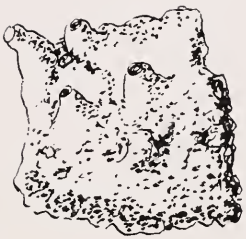
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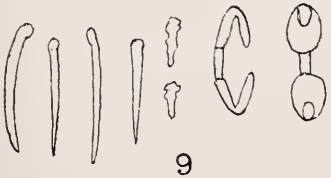
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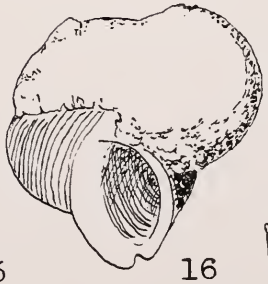
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PLATE 3

## PLATE 3

*Polymastia andrica* n. name (p. 22)

Fig. 19. Colony, from Gulf of St. Lawrence. Natural size. Copied from Lambe, 1896, pl. 3, fig. 1.

Fig. 20. Typical spicules, tylostyles, from same. (x 60)

*Cliona celata* (p. 23)

Fig. 21. Fragment of sponge, from Woods Hole. (x ¼).

Fig. 22. Spicules. (x 100).

*Craniella crania* (p. 25)

Fig. 23. Colony, from Woods Hole. (x ¼).

Fig. 24. Megascleres. (x 10).

Fig. 25. Microscleres. (x 1000).

*Scypha lingua* (p. 26)

Fig. 26. Four individuals, from Woods Hole. Natural size.

Fig. 27. Triaxon. (x 100).

Fig. 28. Oxeas. (x 100).

*Leucosolenia cancellata* Verrill (p. 28)

Fig. 29. Simple and branching tubes, from neotype from Woods Hole. (x 2).

Fig. 30. Triaxon. (x 100).

Fig. 31. Oxeas. (x 100).

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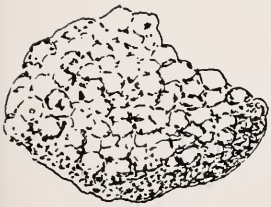

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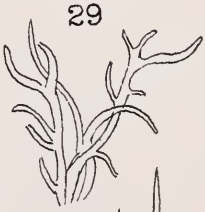

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**Bulletin of the Museum of Comparative Zoölogy**
AT HARVARD COLLEGE
Vol. 103, No. 2

# REPTILES FROM THE INDIAN PENINSULA IN THE MUSEUM OF COMPARATIVE ZOÖLOGY

By John D. Constable

CAMBRIDGE, MASS., U.S.A.
PRINTED FOR THE MUSEUM
May, 1949

No. 2. — *Reptiles from the Indian Peninsula in the Museum of Comparative Zoölogy.*

By John Davidson Constable

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## INTRODUCTION

Since the earliest days of biology, taxonomy has been one of its most important branches. From the time of Aristotle men have been listing, naming, and classifying plants and animals, their attention largely confined at first to those plants or animals that were either very conspicuous or of use to man. Until relatively recently the majority of biologists have been taxonomists to some extent, although today such fields as physiology, development, and genetics, that often involve experimentation, may have become more important than taxonomy.

Taxonomy in itself may seem to be of rather little use, but it is an essential adjunct to other important areas of biology. I believe it to be, in general, a tool developed by scientists for their convenience and that therefore the rules and methods that are adopted for its development should be largely determined by their usefulness rather than by more or less abstract concepts of "natural distinctions." It may, for example, be true that two races of snakes can be distinguished on the basis of differences in the hemipenis, but I consider

the difference to be unworthy of taxonomic recognition as long as the females are indistinguishable. Even if the hemipenis differences should be shown to have such a profound effect upon their breeding habits as to prevent cross-breeding of the two forms, I would still consider a new name inconvenient and hence, almost by definition, unnecessary.

Many of the topics that might be correlated with a taxonomic study such as this require large series of specimens from one relatively restricted locality. This is particularly true in the study of the limits of variability within a taxonomic entity and in attempting to distinguish populations by means of average characters. The Indian collections in the Museum of Comparative Zoölogy are, unfortunately, very deficient in respect to such large series. Of all the species discussed only half a dozen are represented by more than three or four specimens from any one area.

The collections are, however, of importance in other directions. They consist of 775 specimens representing 219 species or forms: of crocodilians 2, chelonians 13, lizards 93, and snakes 112. These include two species not previously described, two that seem to have been known before from only a single specimen, several types, and many topotypes. Although the majority of these reptiles were received at the museum over sixty years ago, very few of them have been adequately studied or described.

I have, therefore, individually examined every specimen, except for a few mounted cobras and pythons, and determined its squamation. In this paper the statistical results of this examination are presented under each species in order to facilitate identification and the definition of geographical races by other students.

Under the name of each species I have first quoted the original citation and type locality. Where these are based upon the plates in Russell's *Indian Serpents* (1796, 1801–1809), the reference to Russell has not been included. The sex of each example is then listed in most groups. This has been determined by dissection except for those lizards in which the males may be distinguished by their pores. The duplication of sex symbols (♂, ♀, or juv.) not preceded by a figure indicates two examples. Symbols separated by a comma always refer to individual specimens. When a juvenile (less than two-thirds the adult size) has been sexed, the ♂ or ♀ is followed by 'juv.' in parentheses. The departmental registration number and locality are listed after the sex. When known, the collector's name is given; if this is unknown, then the source from which the reptile reached the Museum.

The same applies to the date, which is the date of collection if known, otherwise the date of arrival at the Museum. It might be well to note here that the reptiles for which the date 1908 is listed were obtained at this time from the Indian Museum, although the name of the original collector is generally given. The letters N.D. indicate those specimens that lack any date. An analysis of the squamation of our examples follows. The number(s) of the labial(s) entering the orbit is indicated in parentheses after the number of upper labials. The temporals are divided into anterior and posterior (first and second figures respectively). The measurements of length given for each species refer to the largest specimen unless otherwise noted.

## LOCALITIES AND GAZETTEER

The region covered by this paper is all of the Indian mainland formerly included in the British Empire. It does not include Burma, Ceylon, or other islands in the Indian Ocean. The paper was nearly completed before the recent separation of Pakistan from India, and I have not separated the localities on this basis. Considerable difficulty has been experienced with many of the less well known place names, the spellings of which vary widely. In the gazetteer that follows I have listed all the localities from which the Museum of Comparative Zoölogy has material and have indicated their position more fully. In the three cases where I have been unable to find the locality in any atlas or gazetteer it is listed as "not found." The type localities are not included in the gazetteer but, where possible, I have followed the same authorities as for those that are listed.

## GAZETTEER

Spelling is according to the following authorities:

I. The National Geographic Society map of "India and Burma," Washington, D.C., April, 1946.

II. *The Imperial Gazetteer of India*, 3rd. ed. revised, 26 vols., Oxford, 1907–09, if listed therein but not on the National Geographic map.

III. The most recent atlas or gazetteer in which the locality could be found.

Agra, United Provinces

Ambala, Ambala Dist., Punjab

Anaimalai Hills, Coimbatore Dist., Madras

Baluchistan

Bangalore, Mysore

Beas River, N.E. Punjab

Benares Dist., United Provinces
Berar
Bombay
Calcutta, Bengal
Chanda Dist., Central Provinces
Cherrapunji, Khasi Hills, Khasi States
Chilka Lake, Puri Dist., Orissa
Coonoor, Nilgiris Dist., Madras
Cutch, States of Western India
Darjeeling Dist., Bengal
Delhi
Dhamoa River, Orissa (not found)
Ellora, Aurangabad Dist., Hyderabad
Fyzabad Dist., United Provinces
Ganges River
Ganjam, Orissa
Gwadar, Kalat Dist., Baluchistan
Himalayas
Indus Valley
Jeypore, Koraput Dist., Orissa
Jumna River, United Provinces
Kanara Dist., Bombay
Karachi, Sind
Karauli Dist., Rajputana
Karwar, Kanara Dist., Bombay
Kathiawar, Gujarat States
Kharu, on the Shyok River, Ladakh, Kashmir
Khasi Hills, Assam and Khasi States
Kodaikanal, Palni Hills, Madura Dist., Madras
Kolassy, Purnea Dist., Bihar (not found)
Kollegal, Coimbatore Dist., Madras
Kudremukh, Western Ghats
Kulu (Valley), Kangra Dist., Punjab
Kurseong, south of Darjeeling, Bengal (88°16′E. Long. 26° 50′ N. Lat.)
Ladakh, Kashmir
Ludhiana Dist., Punjab
Madras
Malabar Dist., Madras
Matheran, Kolaba Dist., Bombay
Nemotha, near Silchar, Cachar Dist., Assam
Nilambur, Malabar Dist., Madras
Nilgiris Dist., (or Nilgiri Hills), Madras
Nushki, Chagai Dist., Baluchistan
Pamban Island, Ramnad Dist., Madras
Panchgani, Satara Dist., Bombay

Palni Hills, Madura Dist., Madras
"Pegu, Burma"
Pondichéry
Periyakulam, Madura Dist., Madras
Quetta, Quetta-Pishin Dist., Baluchistan
Rungeel Valley, Sikkim (not found)
Sabathu, Simla, Punjab States
Salt Range, Attock and Shahpur Dists., Punjab
Samaguting, Naga Hills, Assam
Sevagiri Hills, Tinnevelly Dist., Madras
Shembaganur, 8 miles north of Periyakulam, Palni Hills, Madura Dist., Madras
Sheveroy Hills, Salem Dist., Madras
Shillong, Khasi Hills, Khasi States
Sibpur, Howrah, Bengal
Sibsagar, Naga Hills, Assam
South Kanara Ghats, Kanara Dist., Bombay
Saoreni, south of Darjeeling, Bengal (88° 12′ E. Long., 26° 50′ N. Lat.)
Taliparamba, Malabar Dist., Madras
Tellicherry, Malabar Dist., Madras
Teynampet, Madras City, Madras
Tinnevelly Hills, Tinnevelly Dist., Madras
Tista Valley, Bhutan Border, Sikkim
Tragbul Pass, 30 miles N.N.W. of Srinagar, Anantnag Dist., Kashmir
Travancore (Hills), Madras States
Trivandrum, Madras States
Wynaad, Malabar Dist., Madras

## SOURCES OF MATERIAL

Although the reptiles in the Museum of Comparative Zoölogy have come to us from thirty-five different sources, almost all of them are from six donors, one dealer, and two museums.

The most important single donor was Colonel R. H. Beddome, who sent many collections during the period 1870–1877: a total of 204 specimens representing 61 different species. These collections are of additional importance in that some of them were identified by Beddome as topotypes of species that he himself had described, and may, indeed, have formed parts of the original series from which the types were selected. It is unfortunate that nearly all this material is poorly localized as 'near Madras,' which term apparently included an extensive area.

Very well localized, however, are the collections of the Reverend M. M. Carleton, almost all of which were made in a small region of

the Punjab. From this source the Museum received (from 1871–1880) 230 specimens including 39 species.

When Thomas Barbour gave his own herpetological collection to the Museum in 1903, it included 5 Indian reptiles, all different species. His 1906–07 (wedding) trip around the world further enriched the Indian collections with 41 specimens which included 13 species.

Another source of material was William Theobald, who in 1866 presented a total of 27 examples of 17 species. It is much to be regretted that Theobald gave such unreliable localities with his reptiles since many of the specimens are of great interest.

From Colonel Frank Wall the Museum received 32 specimens (13 species) from 1921 to 1924.

A portion of Dr. M. A. Smith's important collection of sea snakes was received in 1927, of which 10, representing 9 species, came from waters included in the scope of this paper.

Indian reptiles have been received in smaller numbers from other donors at various times: J. M. Barnard (2), J. J. Carleton (6), E. D. Franklin (1), T. H. Hornaday (2), Arthur Loveridge (3), D. C. Scudder (5), W. C. Scudder (1), Percy Watson (2), and Franz Werner (1).

26 Indian reptiles representing 21 species were purchased from E. Gerrard in 1877–86 by Alexander Agassiz. In 1883 a small series (8) of 6 different sea snakes was bought from H. A. Ward of Rochester.

One of the best methods of rounding out collections has always been exchange with other museums and this has been done with some success in the case of our Indian reptiles, though it is hoped that more will soon be possible. The first Indian material to be received in this way was a half dozen specimens from the Paris Museum through A. A. Duméril. There have been two other museums with whom exchanges of Indian material have been extensively carried on. A total of 43 examples (29 species) have come from the British Museum in five exchanges from 1885 to 1946. The most magnificent exchange of all was made in 1908 and 1935 through N. Annandale at the Indian Museum, from whom we received 74 Indian specimens (72 being lizards) representing 71 species, most of which are otherwise unrepresented in the collection. These lizards are of additional importance in that many were taken by celebrated collectors such as Blanford, Maynard, Alcock, Jerdon, and Stoliczka. Some of these lizards may be typical material, but in most cases the original descriptions are too vague as to the number or source of the types for any certain identification to be made. There have been other minor exchanges with the

Australian Museum (1), Basel Museum (1), Berlin Museum (2). Boston Society of Natural History (1), Madras Museum (4), New York Zoölogical Society (1), Peabody Academy of Salem (4), Senckenberg Museum (5), and the United States National Museum (1).

## ACKNOWLEDGEMENTS

I want to thank first Dr. Malcolm Smith who has been most kind in answering questions and whose works on Indian herpetology have been my guide. I am also indebted to the American Museum of Natural History for the loan of three Uropelts and to the members of the library staff of the Museum of Comparative Zoölogy who have been unfailing in their willingness to help me trace various references. I further want to thank Mr. James L. Peters for help in certain problems concerning the international rules of nomenclature and Mr. Benjamin Shreve for looking over the manuscript. Above all it is impossible for me to express adequately my gratitude to Mr. Arthur Loveridge, at whose suggestion this work was started and without whose constant advice it would never have been completed.

## SUMMARY OF TAXONOMIC ALTERATIONS

This report consists principally of a correlation of the Indian reptile specimens in the Museum of Comparative Zoölogy with the descriptions given by Dr. Malcolm Smith in his definitive works on Indian herpetology.

As a result of this study the following species have been described for the first time:

*Gymnodactylus malcolmsmithi*, pp. 80–82

*Typhlops loveridgei*, pp. 110–111

the undermentioned have been reinstated as subspecies:

*Boiga ceylonensis nuchalis* (Günther), pp. 142–143

*Echis carinatus pyramidum* (Geoffroy), pp. 155–156

the following are regarded as subspecies:

*Psammophilus blanfordanus* (Stoliczka) as a subspecies of *P. dorsalis* (Gray), p. 94

*Lygosoma* (*Leiolopisma*) *laterimaculatum* Boulenger as a subspecies of *L.* (*L.*) *bilineatum* (Gray), pp. 104–105

*Lycodon travancoricus* (Beddome) as a subspecies of *L. aulicus* (Linnaeus), p. 135

*Natrix beddomii* (Günther) as a subspecies of *N. stolata* (Linnaeus), pp. 138–139

the undermentioned is believed to be a synonym:

*Uropeltis phipsonii* (Mason) = *U. rubrolineatus* (Günther), pp. 120–122

the specific distinction of the following is considered questionable:

*Lygosoma (Leiolopisma) ladacense* (Günther) and *L. (L) himalayanum* (Günther), pp. 102–103

*Riopa albopunctata* (Gray) and *R. punctata* (Gmelin), pp. 105–106

and the following are believed doubtfully distinct:

*Python molurus orbiculata* Deraniyagala and *P. m. molurus* (Linnaeus), p. 124

*Python molurus pimbura* Deraniyagala and *P. m. molurus* (Linnaeus), p. 124

*Chrysopelea ornata lankavae* Deraniyagala and *C. ornata* (Shaw), pp. 132–133

## INDIAN REPTILES IN THE MUSEUM OF COMPARATIVE ZOÖLOGY

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## SYSTEMATIC DISCUSSION

## CROCODYLIDAE

### Gavialis gangeticus (Gmelin)

*Lacerta gangetica* Gmelin, 1789, Syst. Nat., **1**, p.1057: Type locality unknown.

1 mtd. (Exhibition) Jumna River (T. H. Hornaday) N.D.
1 mtd. (M. C. Z. 5263) India (H. A. Ward) 1883.
skull (M. C. Z. 29777) India (E. Gerrard) 1931.
skull (M. C. Z. 33950) Jumna River (T. H. Hornaday) 1932.
skull (M. C. Z. 46551) India (Peabody Mus., Salem) 1942.

Upper teeth on either side 28–29, in each premaxilla 5; mandibular teeth on either side 25–26; nuchals together with dorsals form a continuous series of 21 transverse and 4 longitudinal rows; post-occipitals 2, or 2 with 2 smaller ones diagonally anterior to the larger pair in the exhibited specimen. Length of exhibited specimen 3320 (1900 + 1420) mm.; overall length of largest skull (M. C. Z. 46551), 890 mm.

### Crocodylus palustris palustris (Lesson)

*Crocodilus palustris* Lesson, 1834, in Belanger, Voyage Ind. Orient., Zool., p. 305: Ganges River, India.

alcoholic ♀ (juv.)(M. C. Z. 3835) Kanara, Bombay(E. Gerrard) 1878.
skull (M. C. Z. 4036) India (E. Gerrard) 1878.
skull (M. C. Z. 4371) India (E. Gerrard) 1878.

Upper teeth on either side 19, in each premaxilla 5; premaxillo-maxillary suture fairly straight; nuchals 4 large and 2 small; post-occipitals 4; dorsal scutes missing in M. C. Z. 3835; webbing of fingers and toes normal. Length of juvenile ♀, 301 (160 + 141) mm.; overall length of larger skull (M. C. Z. 4371), 610 mm.

Trinomials are used to distinguish between this Indian form and the Ceylon subspecies — *C. palustris kimbula* Deraniyagala of which there are paratypes in the Museum of Comparative Zoölogy.

## CHELONIIDAE

### Eretmochelys imbricata (Linnaeus)

*Testudo imbricata* Linnaeus, 1766, Syst. Nat. (ed. 12), **1**, p. 350: American and Asiatic Seas.

*Eretmochelys squamata* Agassiz, 1857, Contr. Nat. Hist. United States, **1**, p. 382: Indian and Pacific Oceans.

juv. (M. C. Z. 1415) Bengal (J. M. Barnard) 1857.

Jaws hooked; prefrontals 4; carapace tricarinate; shields imbricate; nuchal 1; costals 4 pairs; vertebrals 5; marginals 12 pairs; enlarged inframarginals 5 on each side; pygal absent; hind limb with 2 claws. Color above, dark brown; below blackish. Length of shell 73 mm.

This specimen is a cotype of the alleged Pacific race *squamata*.

### Chelonia mydas (Linnaeus)

*Testudo Mydas* Linnaeus, 1758, Syst. Nat. (ed. 10), **1**, p. 197: Ascension Island.

juv. (M. C. Z. 1414) Bengal (J. M. Barnard) 1857.

Jaws not hooked; prefrontals 2; carapace unicarinate with indications of lateral keels; shields juxtaposed; nuchal 1; costals 4 pairs; vertebrals 5; marginals 12 pairs; enlarged inframarginals 4 on each side; pygal absent; hind limb with 1 claw. Color normal for young. Length of shell 58 mm.

This turtle was originally identified as *C. m. japonica* (Thunberg), but I follow Dr. Malcolm A. Smith (1931, p. 70) in considering this name synonymous with *mydas*.

### Lepidochelys olivacea (Eschscholtz)

*Chelonia olivacea* Eschscholtz, 1829, Zool. Atlas, p. 3, pl. iii: Manila Bay, Philippine Islands.

5 juv. (M. C. Z. 4003, 4018) Calcutta (W. Theobald) 1866.

Jaws hooked; prefrontals 4 or 5 (in one example only); carapace tricarinate in all these juveniles; shields juxtaposed; nuchal 1, in contact with the first costals in all examples except M. C. Z. 4003A where it is separated, although this character is used in Carr's (1942, p. 4) key to the genera of Cheloniidae; costals 5–7 pairs; vertebrals 6–7 (7 in one example only); marginals 13 pairs; enlarged inframarginals 4 on bridge with 3–7 elsewhere; intergular absent; pygal absent; hind limb with 2 claws. Color above, uniformly dark; below paler. Length of shells 35–41 mm.

Many authors have regarded *L. olivacea* as synonymous with *Caretta caretta*, or at most (M. A. Smith, 1931, p. 71) a race. Recently, however, Carr (1942, p. 2) has shown that, together with *L. kempii*, it is generically distinct.

## EMYDIDAE

### Geoemyda trijuga trijuga (Schweigger)

*Emys trijuga* Schweigger, 1814, Prodr. Monog. Chel., p. 41: "Java."

♀ (M. C. Z. 13193) No locality (E. D. Franklin) 1913.
♀ (M. C. Z. 20166) No locality (N. Y. Zool. Soc.) N. D.

Upper jaw notched, scarcely projecting mesially; bony temporal arch present; skin on hinder part of head somewhat divided into large shields; shell tricarinate, not serrated posteriorly; plastron deeply notched posteriorly; neural plates hexagonal, short-sided behind; shields juxtaposed; nuchal small, pointed anteriorly; costals 4 pairs; vertebrals 5–6; marginals 12 pairs; axillary present; inguinal absent; pygal absent; front limb with 5 claws, hind limb with 4. Color apparently normal for *trijuga trijuga* but the racial determination of these non-localized specimens must remain questionable. Length of ♀ carapace (M. C. Z. 13193), 160 mm.

### Geoemyda trijuga indopeninsularis Annandale

*Geoemyda indopeninsularis* Annandale, 1913, Rec. Indian Mus., 9, p. 71, pls. v-vi: Singhbhum District, Chota Nagpur, India.

1 mtd. (Exhibition) Calcutta (No further data).

Similar to *G. t. trijuga*, but on account of its locality this specimen, whose head coloration cannot be satisfactorily ascertained, is referred to *indopeninsularis*. Length of carapace, 186 mm.

### Geoclemys hamiltoni (Gray)

*Emys hamiltoni* Gray, 1831, Illus. Indian Zool., pt. 6, pl. ix (bearing caption *guttata*): India.

♀ (M. C. Z. 4004) Calcutta (W. Theobald) 1866.
1 mtd. ♀ (M. C. Z. 6759) India (T. Barbour) 1903.

Upper jaw slightly projecting, broadly emarginate mesially; bony temporal arch present; skin on hinder part of head divided into large shields; shell tricarinate, slightly serrated posteriorly; plastron deeply notched posteriorly; neural plates hexagonal, short-sided in front; shields juxtaposed; nuchal small to moderate, broadest posteriorly; costals 4 (5 on one side of M. C. Z. 6759) pairs; vertebrals 5; marginals 12 pairs; axillary and inguinal present; pygal absent; front limb with 5 claws, hind limb with 4. Color normal. Length of carapace of mounted example, 226 mm.

### Hardella thurgii (Gray)

*Emys thurgii* Gray, 1831, Syn. Rept., pp. 22, 72: India.

♀ ♀ (M. C. Z. 4002) Calcutta (W. Theobald) 1866.

Upper jaw strongly projecting, much denticulated; bony temporal arch present; skin on hinder part of head divided transversely into small scales; shell unicarinate, slightly serrated posteriorly; plastron notched posteriorly; neural plates hexagonal, short-sided behind; shields juxtaposed; nuchal moderate, broadest posteriorly; costals 4 pairs; vertebrals 5; marginals 12 pairs; axillary and inguinal present; pygal absent; front limb with 5 claws, hind limb with 4. Color normal. Length of carapaces, 98 and 107 mm.

On page 22 of his original description Gray three times spells the name *Thurjii,* but on page 72 of the "Additions and Corrections" he gives it as *Thurgii,* which corrected form I use. In the Illustrations of Indian Zoology — which presumably appeared after the Synopsis Reptilium — the name appears as *Thuji.*

### Kachuga smithii (Gray)

*Batagur smithii* Gray, 1863, Proc. Zool. Soc. London, p. 253: Chenab River, Punjab, India.

1 shell (Exhibition) Bengal (No further data).
1 juv. (M. C. Z. 3233) Ludhiana, Punjab (M. M. Carleton) 1871.

Upper jaw strongly projecting, not notched, finely denticulated; bony temporal arch present; skin on hinder part of head divided into large, fairly symmetrical shields; shell unicarinate, very slightly serrated posteriorly; plastron not very deeply notched posteriorly; neural plates hexagonal, short-sided in front; shields juxtaposed;

nuchal small, almost rectangular; costals 4 pairs; vertebrals 5; marginals 12 pairs; axillary and inguinal present; pygal absent; front limb with 5 claws, hind limb with 4. Color normal, the alcoholic specimen showing a large brownish patch on the upper surface of the neck. Length of carapace in exhibition specimen, 165 mm.

### Kachuga tectum tectum (Gray)

*Emys tectum* Gray, 1830, Illus. Indian Zool., pt. 2, pl. vii; 1831, **1**, pl. lxxii: India.

1 mtd. (M. C. Z. 4005) Calcutta (W. Theobald) 1866.

Upper jaw fairly strongly projecting, finely denticulated; bony temporal arch present; skin on hinder part of head divided into large shields; shell unicarinate, very slightly serrated posteriorly; plastron not very deeply notched posteriorly; neural plates hexagonal, short-sided in front; shields juxtaposed; nuchal very small, broadest posteriorly; costals 4 pairs; vertebrals 5; marginals 12 pairs; axillary and inguinal present; pygal absent; front limb with 5 claws, hind limb with 4. Color normal for *t. tectum*. Length of carapace, 95 mm.

### Kachuga dhongoka (Gray)

*Emys dhongoka* Gray, 1834, Illus. Indian Zool., **2**, pl. lx: North India.

3 shells (M. C. Z. 4001) Bengal (No further data).

Shell unicarinate, slightly serrated posteriorly; plastron deeply notched posteriorly; neural plates hexagonal, short-sided in front; shields juxtaposed; nuchal small, much broader posteriorly; costals 4 pairs; vertebrals 5; marginals 12 pairs; axillary and inguinal present; pygal absent. Color normal with faint longitudinal stripes. Length of largest carapace, 218 mm.

## TESTUDINIDAE

### Testudo elegans Schoepff

*Testudo elegans* Schoepff, 1792, Hist. Test., p. 111, pl. xxv: India.

1 mtd. (M. C. Z. 6937) Calcutta (T. Barbour) 1903.
♂ (M. C. Z. 18376) Assam (A. Loveridge) 1924.

Upper jaw projecting, slightly tricuspid; head with a pair of enlarged prefrontals, otherwise covered with small irregular scales; shell not carinate, but each vertebral and costal markedly humped, deeply serrated posteriorly; plastron notched posteriorly; neural plates alternately tetragonal and hexagonal; shields juxtaposed; nuchal absent; costals 4 pairs; vertebrals 5; marginals 11 pairs; axillary and inguinal rather small; pygal present; front limb with 5 claws, hind limb with 4. Color normal except that in both examples the number of streaks on each shield is often less than eight; in M. C. Z. 6937 four shields have only 5–7 streaks, while in M. C. Z. 18376 one has 5, five have 6, two have 7, and only five have 8 or more streaks. Length of carapace (M. C. Z. 6937), 135 mm.

## TRIONYCHIDAE

### Lissemys punctata punctata (Bonnaterre)

*Testudo punctata* Bonnaterre, 1789, in Daubenton, Tab. Encycl. Méth., Erpét., p. 30, pl. vi, fig. 4: Les Grandes Indes.

juv. (M. C. Z. 4006) Calcutta (W. Theobald) 1866.
juv. (M. C. Z. 4174) India (E. Gerrard) 1877.
♂ (M. C. Z. 28642) Benares (Brit. Mus.) 1929.
skull (M. C. Z. 49013) India (E. Gerrard) 1877?

Neural plates 7–8; nuchal plate large; a prenuchal marginal; costal plates 8 pairs, the last 2 pairs forming a median suture; a series of posterior margin plates present; plastral callosities 7; front limb with 3 claws, hind limb with 3. Color normal, the spots very faint in M. C. Z. 4174. Length of bony carapace (M. C. Z. 28642), 130 mm.

### Chitra indica (Gray)

*Trionyx indicus* Gray, 1831, Syn. Rept., p. 47: Fatehgarh, Ganges River, India.

1 skeleton (Exhibition) India (No further data).

Neural plates 8; nuchal plate overlying second dorsal rib; costal plates 8 pairs, the last pair in contact on the median line; hyoplastron and hypoplastron distinct, separate. This specimen is unusual in having 4 pairs of bones in the body of the hyoid, while, according to Dr. Malcolm Smith (1931, p. 152) "three appear to be constantly present in *Chitra*." Length of bony carapace, 490 mm.

## GEKKONIDAE

### Teratoscincus scincus (Schlegel)

*Stenodactylus scincus* Schlegel, 1858, Handl. Dierk., **2**, p. 16: Ili River, Turkestan.

♂ (M. C. Z. 7126) Baluchistan (F. P. Maynard) 1908.

Upper labials 10–11; lower labials 8–9 (10–12 is given as the usual range by M. A. Smith, 1935, p. 31); postnasals 2; midbody scale rows 34. The coloration is very well defined in our example, which shows four irregular blackish crossbars on the back and four on the top of the tail; there are also remnants of four longitudinal black stripes on the back, and the head is distinctly and elegantly marked with dark brown. Total length of ♂, 122 (72 + 50) mm.

### Stenodactylus lumsdenii Boulenger

*Stenodactylus lumsdenii* Boulenger, 1887, Cat. Liz. Brit. Mus., **3**, p. 479: in the sandy desert between Nushki and Helmand, North Baluchistan, India.

♂ (M. C. Z. 7137) Baluchistan (F. P. Maynard & A. H. MacMahon) 1908.

This well-preserved gecko is apparently the first known male of a rare species until now known only from the female type. It was received in exchange from the Indian Museum as *Agamura persica*. Our male agrees with the description of the type as given by M. A. Smith (1935, p. 35) except in coloration; instead of the 7 distinct crossbars on the back M. C. Z. 7137 has 6 wide w-shaped bars with indications of 4 very narrow longitudinal ones; in addition it has 10 dark bands on the tail, and a blackish curved mark on the neck. It has 7 preanal pores and shows very marked swellings at the base of the tail. Total length of ♂, 99 (44 + 55) mm., which is 26 mm. longer than the type.

### Alsophylax tuberculatus (Blanford)

*Bunopus tuberculatus* Blanford, 1874, Ann. Mag. Nat. Hist. (4), **13**, p. 454: Baluchistan, India.

♀ cotype (M. C. Z. 7128) Baluchistan (W. T. Blanford) 1874.

Upper labials 11; lower labials 10. In coloration the dark brown spots scarcely form crossbars on the back. Total length of ♀, 76 (34 + 42) mm.

### Gymnodactylus malcolmsmithi spec. nov.

*Type.* Museum of Comparative Zoölogy, No. 3252, an adult male from the Beas River basin, Punjab, India, collected by the Rev. M. M. Carleton about 1872.

*Paratype.* Museum of Comparative Zoölogy, No. 4335, a juvenile from the Kulu Valley, Punjab, India, taken by the same collector, also about 1872.

The localities on these specimens seem likely to be correct, as nearly all the work of this collector was done in one small area.

*Diagnosis.* Considerable difficulty was experienced in determining whether these lizards should be assigned to the genus *Gymnodactylus* or *Hemidactylus*. Unfortunately their condition does not permit a wholly satisfactory examination of the digits, which apparently exhibit a moderate dilation, there being about 8–9 lamellae under the fourth toe; one or two of the lamellae give the appearance of being divided — particularly in the larger specimen. Mr. Loveridge very kindly examined these lizards at my request and concluded that the digital condition is closest to that found in *Gymnodactylus*, even though in some ways approaching *Hemidactylus*. The smaller gecko was sent to Dr. Malcolm Smith who was good enough to examine it and state that he considered it to be a new *Gymnodactylus*. I shall, therefore, place these lizards in the genus *Gymnodactylus* even though it will be necessary for the purpose of diagnosis to compare them with some species of *Hemidactylus*.

These two geckos show considerably greater expansion of the digits than do any other Indian *Gymnodactylus* examined, although this may be partly due to their rather swollen and macerated condition. They differ from all the *G. scaber* group in their less massively developed dorsal tubercles, and in the number and arrangement of the preanofemoral pores. They differ from all the *G. pulchellus* group in length of limb, arrangement of the pores, or in range; and from other *Gymnodactylus* in the presence of pores and of enlarged transverse plates beneath the tail.

The new lizards differ from all the Indian *Hemidactylus* in their digits, but most nearly approach *H. maculatus* from which they further differ in the size of the ear-opening, development of the post-

mentals, size of the dorsal tubercles, number of preano-femoral pores, length of limb, range and size. In addition to digital expansion both our geckos differ from other Indian species of *Hemidactylus* in at least two of the following characters: size and development of the dorsal tubercles, number of subdigital lamellae, size of ear-opening, number and arrangement of pores, or range.

*Description.* (Paratype data, where differing from that of the type, included in parentheses). Head and body depressed; head moderate; snout longer than the distance between the eye and the ear-opening, which is about as large as the first upper labial; upper labials (11) −12; lower labials (8) −10; rostral broader than high, with median cleft above; nostril between the rostral and 3 nasals, not (or just in paratype) including the first labial; a pair of internasals separated by a single scale; head covered above with rounded granular scales which are largest upon the canthus rostralis; mental large, subtriangular, twice as long as the adjacent labials; two pairs of postmentals, the inner pair well developed and in contact behind the mental, the outer pair much (somewhat) smaller and separated (not in paratype) by a row of small scales from the lower labials; the flat granular scales behind the postmentals are somewhat enlarged and merge gradually into the very small scales of the gular region.

Back with small granular scales intermixed with rather irregular rows of much larger, rounded, keeled tubercles which at midbody are arranged in about 16 oblique rows across the back (i.e. 8 on each side of the vertebral line); no enlarged scales on the very slight lateral folds which are separated across the middle of the belly by about 36 rounded, imbricate scales; the adpressed hind limb reaches to a point considerably short of the axilla; digits elongate with exceptionally well developed lamellae for this genus, 8–9 under the fourth toe (see diagnosis above for further discussion of this character). Tail rather strongly depressed, oval in section, covered above with small imbricate scales and regular series of large keeled tubercles, 6 in a row except at the very base where there are 8 (not in paratype); below is a median series of transversely enlarged plates which are divided into two at the base of the tail and which are never as broad as the tail. Male with 12 (no count possible on paratype) preano-femoral pores separated mesially by two (one in paratype) scales from those on the other side.

*Color.* Both specimens are in poor condition. The type is faded and is at present pallid buff above; on the occiput an indistinct pale horseshoe-shaped mark connects with the posterior corners of the upper eyelids. A light vertebral line. Possibly some indication of darker

transverse barring on the limbs and tail. Below, white, uniform. The paratype is gray above, limbs brownish. Below, paler gray (possibly discolored).

*Size.* Type. Length from snout to vent 55 mm., tail 45 mm., but tip regenerated. Paratype. Length from snout to vent 38 mm., tail 44 mm.

*Remarks.* I take great pleasure in naming this interesting new gecko after Dr. Malcolm A. Smith whose three definitive volumes on Indian reptiles have been my constant guide, and whose help in answering questions has been of great service to me.

### Gymnodactylus fedtschenkoi Strauch

*Gymnodactylus fedtschenkoi* Strauch, 1887, Mem. Acad. St. Pétersb., **35**, p. 46: Samarkand, Turkestan.

♀ ? (M. C. Z. 7129) Salt Range, Punjab (W. Theobald) 1908.

Due to the extreme dessication of this specimen, proper examination and checking of the specific determination prove impossible.

### Gymnodactylus scaber (Heyden)

*Stenodactylus scaber* Heyden, 1827, in Rüppell, Atlas N. Afr. Rept., p. 15, pl. iv, fig. 2: Tor, Sinai, Egypt.

juv. (M. C. Z. 7130) Sind (Indian Mus.) 1908.

Owing to its very poor preservation a satisfactory examination of this tiny gecko could not be made. Length of head and body 20 mm., tail missing.

### Gymnodactylus kachhensis kachhensis Stoliczka

*Gymnodactylus kachhensis* Stoliczka, 1872, Proc. Asiatic Soc. Bengal, p. 79: Cutch, India.

♀ (M. C. Z. 7131) Sind (J. A. Murray) 1908.

Condition very bad; upper labials 10; lower labials 9; apparently referable to the typical race though the number of scales across the belly is indeterminable. Total length of ♀, 71 (42 + 29) mm.

### Gymnodactylus feae Boulenger

*Gymnodactylus feae* Boulenger, 1893, Ann. Mus. Civ. Stor. Nat. Genova (2), **13**, p. 313, pl. vii, fig. 1: Karenni Hills, Burma.

♂ (M. C. Z. 21915) Calcutta (Berlin Mus.) 1925.

Upper labials 10 (+2 or 3 small ones); lower labials 9 or 10. In his original description Boulenger gives the upper labials as 7–8, the lower as 8–9, but Dr. Malcolm Smith, after re-examination of the type, states there are 11–12 upper and 9–10 lower labials (similar to *G. intermedius*) so that M. C. Z. 21915 agrees better with Smith's count.

The identification of this lizard, originally received as *G. pulchellus*, has raised several problems. It seems scarcely possible it could be referred to either *G. consobrinus* or *intermedius*. It shows a clearly defined lateral fold of enlarged scales and has 28 large (+6 or 8 small) scales between the folds; the enlarged tubercles are arranged in 24–26 rather irregular rows.

Although the type is a ♀ Boulenger describes the ♂ as having a "continuous series of 32 pores along the thighs and across the preanal region." This description may have been based on the slightly pitted scales of the ♀ type. Dissection clearly shows our specimen to be a ♂ but it has only a single preanal pore and the series of enlarged, slightly pitted, scales characteristic of the ♀ type.

In coloration our example is similar to the type in the number and shape of its clearly marked dorsal crossbars, but lacks the large brown spots on the head which is uniform pale brown in this case. Its markings closely resemble those of *intermedius* as shown in Smith (1935, pl. i).

The stomach contains beetle and grasshopper remains as well as a coleopterous larva about 32 mm. in length. Total length of ♂, 167 (74 + 93) mm., considerably larger than the type.

### Gymnodactylus khasiensis (Jerdon)

*Pentadactylus khasiensis* Jerdon, 1870, Proc. Asiatic Soc. Bengal, p. 75: Khasi Hills, Assam, India.

♂ topotype (M. C. Z. 7133) Cherrapunji, Assam (Lt. Bourne) 1908.

Upper labials 12; lower labials 10; preanal pores 12. Total length of ♂, 122 (83 + 39) mm., but tail regenerated.

### Gymnodactylus nebulosus Beddome

*Gymnodactylus nebulosus* Beddome, 1870, Madras Month. Journ. Med. Sci., **2**, p. 174: Golconda Hills near Vizagapatam, India.

♂ (M. C. Z. 49109) Nilambur, Madras (Brit. Mus.) 1946.

Upper labials 10; lower labials 10; no pores. Total length of ♂, 67+ (42 + 25+) mm., but tail regenerated. Collected by R. H. Beddome.

### Gymnodactylus stoliczkai Steindachner

*Gymnodactylus stoliczkai* Steindachner, 1869, Reise Novara, Rept., p. 15, pl. ii, fig. 2: near Karoo, north of Dras, Kashmir, India.

♂ (M. C. Z. 7132) Ladakh (F. Stoliczka) 1908.

Upper labials 9; lower labials 8; no pores. Total length of ♂, 85 (48 + 37) mm.

### Gymnodactylus lawderanus Stoliczka

*Gymnodactylus lawderanus* Stoliczka, 1871, Proc. Asiatic Soc. Bengal, p. 194, and 1872 Journ. Asiatic Soc. Bengal, **41**, p. 105, pl. ii, fig. 4: Almora, Kumaon, India.

♂ (M. C. Z. 3152) Ambala (M. M. Carleton) 1873.
3 ♂ ♂, ♀ (M. C. Z. 3442, 4803) Kulu Valley (M. M. Carleton) 1873–4.
♂ (M. C. Z. 19569) No data.

Upper labials 9–10; lower labials 8–10; preanal pores 6–8 (4–5 according to M. A. Smith, 1935, p. 59). Total length of ♀ (M. C. Z. 4803), 96 (60 + 36) mm.

### Agamura persica (Duméril)

*Gymnodactylus persicus* Duméril, 1856, Arch. Mus. Hist. Nat. Paris, **8**, p. 481: Persia.

♀ (M. C. Z. 7136) Baluchistan (W. T. Blanford) 1908.

This specimen is a cotype of *Agamura cruralis* Blanford. Upper labials 13–14; lower labials 10–11. Total length of ♀, 129 (70 + 59) mm.

### Cnemaspis indica (Gray)

*Goniodactylus indicus* Gray, 1846, Ann. Mag. Nat. Hist., **18**, p. 429: Madras Presidency, India.

♂ topotype (M. C. Z. 7138) Nilgiri Hills (R. H. Beddome) 1908.

Upper labials 7–8; lower labials 6; femoral pores 3 on one side, 4 on the other. Length of head and body, 30 mm.; tail damaged.

### Cnemaspis wynadensis (Beddome)

*Gymnodactylus wynadensis* Beddome, 1870, Madras Month. Journ. Med. Sci., **1**, p. 32: Wynaad, India.

♂ ♂, 5 ♀ ♀ (M. C. Z. 4745) India (R. H. Beddome) 1871.

Upper labials 6–8; lower labials 6–8; femoral pores 4–5 on each side. Length of head and body of largest ♀, 39 mm., tail damaged.

### Cnemaspis ornata (Beddome)

*Gymnodactylus ornatus* Beddome, 1870, Madras Month. Journ. Med. Sci., **1**, p. 32: Tinnevelly, India.

♂, 4 ♀ ♀, juv. (M. C. Z. 4749) No data.
♀ (M. C. Z. 7139) Travancore (R. H. Beddome)1908.
♀ (M. C. Z. 28650) Wynaad (Brit. Mus.) 1929.

There is some doubt as to the identification of M. C. Z. 7139 which is not in very good condition. M. C. Z. 28650 was received as *C. marmoratus* Beddome, which is a synonym of *C. beddomei* (Theobald). Upper labials 6–8; lower labials 6–8; preanal pores only 5 in male. Length of head and body of ♀ (M. C. Z. 28650), 52 mm.; tail damaged.

### Cnemaspis kandiana (Kelaart)

*Gymnodactylus kandianus* Kelaart, 1852, Prod. Fauna Zeyl., p. 186: Hills round Kandy, Ceylon.

4 ♂ ♂, 5 ♀ ♀ (M. C. Z. 3927, 4751) Madras (R. H. Beddome) N. D.
♂, ♀ ♀ (M. C. Z. 4752) India (R. H. Beddome) N. D.

Upper labials 7–8; lower labials 7–8; preanal pores 2, femoral pores 3–4 in males. Length of head and body of largest ♂, 44 mm., tail damaged.

### Cnemaspis gracilis (Beddome)

*Gymnodactylus gracilis* Beddome, 1870, Madras Month. Journ. Med. Sci., **1**, p. 32: Palghat Hills, Madras Presidency, India.

♀ (M. C. Z. 28651) Sevagiri Hills (Brit. Mus.) 1929.

Upper labials 8; lower labials 8. Total length of ♀, 71 (31 + 40) mm. This gecko conforms perfectly to the description of this rather doubtful species.

### Calodactylodes aureus (Beddome)

*Calodactylus aureus* Beddome, 1870, Madras Month. Journ. Med. Sci., **1**, p. 31, pl. ii: Tiruppatur Hills, Eastern Ghats, India.

♂, ♀, juv. (M. C. Z. 3918) Madras (R. H. Beddome) N. D.

Upper labials 12–13; lower labials 12–13; in so far as our male has 8 preanal and 8 femoral pores on each side (24 in all), it seems probable that the ten specimens examined by M. A. Smith (1935, p. 79) were all females, for in all other respects this gecko conforms perfectly to Dr. Smith's description. Total length of ♂, 151 (70 + 81) mm.

### Hemidactylus maculatus Duméril & Bibron

*Hemidactylus maculatus* (in part) Duméril & Bibron, 1836, Erpét. Gén., **3**, p. 358: Bombay, India.

♀ (M. C. Z. 4148) India (E. Gerrard) 1877.

Upper labials 11–12; lower labials 9; 13 lamellae under the fourth toe. Total length of ♀, 164 (80 + 84) mm.

### Hemidactylus turcicus turcicus (Linnaeus)

*Lacerta turcica* Linnaeus, 1758, Syst. Nat. ed. 10, **1**, p. 202: "Oriente."

♂ ♂ (M. C. Z. 7140–1) Sind (J. A. Murray) 1908.

Upper labials 8–10; lower labials 8–9; lamellae under fourth toe 9–11; enlarged tubercles on dorsum in 14–16 longitudinal rows; preanal pores 6. Total length of ♂ (M. C. Z. 7140), 108 (49 + 59) mm.

M. C. Z. 7141, though received in exchange from the Indian Museum as *H. persicus*, is apparently conspecific with *turcicus* from the same source.

### Hemidactylus triedrus (Daudin)

*Gecko triedrus* Daudin, 1802, Hist. Nat. Rept., **4**, p. 155: Type locality unknown.

♂ ♂ (M. C. Z. 3917) Madras (R. H. Beddome) N. D.
♂ (M. C. Z. 4149) No locality data (E. Gerrard) N. D.
♀ juv. (M. C. Z. 7142) Colagelly Hills (R. H. Beddome) 1908.

This last locality presumably refers to the hills around Kollegal, Madras. The gecko was received in exchange from the Indian Museum in 1908.

Upper labials 8–9; lower labials 8–9 (thus approaching the condition found in *H. subtriedrus*); lamellae under fourth toe 8; preano-femoral pores 6–7 on each side. This series shows well the transitions from juvenile to adult coloration. Total length of ♂ (M. C. Z. 3917), 159 (74 + 85) mm.

### Hemidactylus brookii brookii Gray

*Hemidactylus brookii* Gray, 1845, Cat. Liz. Brit. Mus., p. 153: Borneo (restricted).

7 ♂ ♂, 4 ♀ ♀, 4 juv. (M. C. Z. 3201, 3441, 3752) N. India (M. M. Carleton), 1872–3.
5 ♂ ♂, 6 ♀ ♀, 4 juv. (M. C. Z. 3234, 3242) Bengal (M. M. Carleton) 1872.
♂ ♂ (M. C. Z. 3244) Kulu Valley (M. M. Carleton) 1871.
5 ♂ ♂, 6 ♀ ♀, 3 juv. (M. C. Z. 3747, 20254–20266) 70 miles s.w. of Ambala (M. M. Carleton) 1879.
juv. (M. C. Z. 4069) Ambala (M. M. Carleton) N. D.
♂ (M. C. Z. 7583) Calcutta (T. Barbour) 1906.
♂, ♀, juv. (M. C. Z. 7585) Lucknow (T. Barbour) 1906.
♀ (M. C. Z. 21928) Central India (Berlin Mus.) 1925.

Upper labials 9–11; lower labials 7–9; preano-femoral pores 8–13 on each side in male, not always interrupted mesially. Total length of ♂ (M. C. Z. 20266), 111 (53 + 58) mm.

### Hemidactylus reticulatus Beddome

*Hemidactylus reticulatus* Beddome, 1870, Madras Month. Journ. Med. Sci., **1**, p. 33: Kollegal, India.

♂ (M. C. Z. 49110) Sheveroy Hills (Brit. Mus.) 1946.

Upper labials 9; lower labials 8; lamellae under fourth toe 8; preanal pores 6. Total length of ♂, 66 (35 + 31) mm. This gecko was collected by R. H. Beddome, though not from the type locality.

### Hemidactylus frenatus Duméril & Bibron

*Hemidactylus frenatus* Duméril & Bibron, 1836, Erpét. Gén., **3**, p. 366: Java.

♂ ♂ (M. C. Z. 7618) Calcutta (T. Barbour) 1906.

Upper labials 10–11; lower labials 8–9; in one example a postmental is almost separated from the lower labials by small scales, thus approaching the condition in *H. garnoti*; lamellae under fourth toe 9–10; femoral pores 29–32 altogether. Total length of ♂, 76+ (43 + 33+) mm., but tip of tail missing.

### Hemidactylus leschenaulti Duméril & Bibron

*Hemidactylus leschenaulti* Duméril & Bibron, 1836, Erpét. Gén., **3**, p. 364: Ceylon.

♂ (M. C. Z. 7144) Nilgiri Hills (W. Theobald) 1908.

Upper labials 12; lower labials 9–10; lamellae under fourth toe 11; femoral pores 13 on each side. Total length of ♂, 151 (78 + 73) mm., but tail regenerated.

### Hemidactylus flaviviridis Rüppell

*Hemidactylus flaviviridis* Rüppell, 1835, Neue Wirb. Fauna Abyss., p. 18, pl. vi, fig. 2: Massaua Island, Eritrea.

♀ (M. C. Z. 3153) Ambala (M. M. Carleton) 1873.
♂ ♂ (M. C. Z. 3251) Bengal (M. M. Carleton) 1871.
♀ ♀ (M. C. Z. 7607) Jeypore (T. Barbour) 1906.
♂, ♀ ♀ (M. C. Z. 7610) Delhi (T. Barbour) 1906.

Upper labials 13–15; lower labials 9–12 (9 on several of our specimens though 10–12 is given as the range by M. A. Smith, 1935, p. 98); lamellae under the fourth toe 12–14; femoral pores 5–6 on each side. Our series shows a gradual reduction of enlarged tubercles on body and tail, one specimen exhibits numerous enlarged scales on the flanks and series of 6 upon the tail, others show a few rather enlarged tubercles

on the sides and series of only about 4 on the tail, while in some there are no enlargements on the body and the tail series consist of only about 3 enlarged scales. Total length of ♀ (M. C. Z. 3153), 146 (67 + 79) mm.

M. C. Z. 7607 and 7610 (5 examples) were previously identified as *H. frenatus* in Barbour (1912, p. 80).

### Hemidactylus bowringii (Gray)

*Doryura bowringii* Gray, 1845, Cat. Liz. Brit. Mus., p. 156: Hongkong or neighborhood.

♀ (M. C. Z. 7145) Sibsagar, Assam (S. E. Peal) 1908·
5 ♂ ♂, 8 ♀ ♀ (M. C. Z. 7581) Tista Valley, Sikkim (T. Barbour) 1906.

Upper labials 9–11; lower labials 7–9; lamellae under fourth toe 10–11; femoral pores 12–14 on each side in the males; tails on several specimens are somewhat segmented. Total length of largest gecko, 108 (54 + 54) mm., but tail damaged.

M. C. Z. 7145 was received from the Indian Museum as *H. garnoti*. The Sikkim series were taken "from the thatched roofs of Butiya's houses" (Barbour, 1912, p. 80).

### Cosymbotus platyurus (Schneider)

*Stellio platyurus* Schneider, 1792, Amphib. Physiol., **2**, p. 30: Type locality unknown.

♀ (M. C. Z. 7146) Samaguting, Assam (Capt. Butler) 1908.

Upper labials 12 (9–11 in M. A. Smith, 1935, p. 103); lower labials 10 (8–9 in Smith, loc. cit.); lamellae under fourth toe 6; outer pair of postmentals not much smaller than the inner pair; no enlarged dorsal tubercles present. Total length of ♀, 116 (54 + 62) mm., but tail damaged.

As shown by G. S. Myers (Copeia, 1943, p. 192) *Platyurus* of Oken, used by M. A. Smith (1935, p. 102, etc.), is preoccupied by *Platyurus* of Ritgen, 1828.

### Gekko gecko (Linnaeus)

*Lacerta gecko*, Linnaeus, 1758, Syst. Nat. (ed. 10), **1**, p. 205: "in Indiis."

♂ (M. C. Z. 7238) Samaguting, Assam (Capt. Butler) 1908.

Upper labials 13–14; lower labials 10–11; preanal pores 12. Total length of ♂, 294 (162 + 132) mm.

### Eublepharis macularius (Blyth)

*Cyrtodactylus macularius* Blyth, 1854, Journ. Asiatic Soc. Bengal, **23**, pp. 737–738: Salt Range, Punjab, India.

♀ (M. C. Z. 4268) Ambala (M. M. Carleton) 1877.
♂ (M. C. Z. 7149) Karachi (Karachi Mus.) 1908.

Upper labials 9; lower labials 9–10; preanal pores 12 in male. These specimens, the ♀ being young, show both juvenile and adult color patterns; the spots derived from the crossbars form longitudinal series in the adult male. Total length of ♂, 220 (125 + 95) mm.

## AGAMIDAE

### Draco dussumieri Duméril & Bibron

*Draco dussumieri* Duméril & Bibron, 1837, Erpét. Gén., **4**, p. 456: Malabar, India.

♂ (M. C. Z. 25909) Portuguese India (F. Werner) 1928.

This flying lizard is unusual in having only 5 patagial ribs, 6 being the normal number according to M. A. Smith (1935, p. 143). Total length of ♂, 191 (77 + 114) mm.

### Sitana ponticeriana Cuvier

*Sitana ponticeriana* Cuvier, 1829, Régne Anim. (ed. 2), **2**, p. 43: Pondichéry, India.

♀ (M. C. Z. 7153) Chanda, Central Provinces (Indian Mus.) 1908.

If a typical smaller form is recognizable, then this agamid is referable to it as defined by Dr. Smith (1935, p. 145). Total length of ♀, 138 (45 + 93) mm.

### Japalura tricarinata (Blyth)

*Calotes tricarinatus* Blyth, 1853, Journ. Asiatic Soc. Bengal, **22**, p. 650: Sikkim, India.

juv. (M. C. Z. 7158) Darjeeling (J. L. Lister) 1908.

Total length of juvenile, 74 (29 + 45) mm.

### Japalura planidorsata Jerdon

*Japalura planidorsata* Jerdon, 1870, Proc. Asiatic Soc. Bengal, p. 76: Khasi Hills, Assam, India.

♀ topotype (M. C. Z. 7197) Nemotha, near Silchar, Assam (J. Wood-Mason) 1908.

This lizard, typical in all other respects, lacks a fold in front of the shoulder and has the hind limb reaching to just beyond the snout, rather than to the ear or nostril as described by Smith (1935, p. 170). Total length of ♀, 117 (44 + 73) mm.

### Japalura variegata Gray

*Japalura variegata* Gray, 1853, Ann. Mag. Nat. Hist. (2), **12**, p. 388: Sikkim, India.

♀ (M. C. Z. 7196) Kurseong, Bengal (N. Annandale) 1908.

This specimen has only a slight blue mark on the gular pouch and shows a handsome, black-edged stripe running from the eye to just above the shoulder. Total length of ♀, 132 (66 + 66) mm., but tail incomplete.

### Salea horsfieldii Gray

*Salea horsfieldii* Gray, 1845, Cat. Liz. Brit. Mus., p. 242: India.

♀ (M. C. Z. 4128) Nilgiri Hills (E. Gerrard) 1877.
♀ (M. C. Z. 7198) Nilgiri Hills (T. C. Jerdon) 1908.

In M. C. Z. 7198 the whitish scales on the flanks are scarcely enlarged and few in number. No. 4128 has a rather larger gular fold and her nuchal crest does not consist of the usual double row described by Smith (1935, p. 178) but more nearly resembles that of a male, though with shorter spines. However, the lizard is a gravid female containing 6 eggs measuring 16 × 8 mm. According to Dr. Smith (1935, p. 179) 3 or 4 is the characteristic number. Total length of ♀ (M. C. Z. 4128), 219 (74 + 145) mm.

### Salea anamallayana (Beddome)

*Lophosalea anamallayana* Beddome, 1878, Proc. Zool. Soc. London, p. 153, pl. xiv: Anaimalai Hills at 6,000 feet, India.

♀ (M. C. Z. 7199) Trivandrum (Trivandrum Mus.) 1908.

This lizard has only about 5 nuchal spines but shows a few fine spines all along the back. Total length of ♀, 234 (83 + 151) mm.

### Calotes versicolor (Daudin)

*Agama versicolor* Daudin, 1802, Hist. Nat. Rept., **3**, p. 395, pl. xliv: India.

♂ (M. C. Z. 1334) Periyakulam, Madura District, Madras (D. C. Scudder) 1865.
3 ♂ ♂ (M. C. Z. 3116) Calcutta (W. Theobald) 1866.
3 ♂ ♂ (M. C. Z. 3235–6, 3248) Bengal (M. M. Carleton) 1870 & 1872.
3 ♂ ♂, ♀ ♀, 8 juv. (M. C. Z. 3237, 3746, 8315–25) 70 miles s.w. of Ambala (M. M. Carleton) 1872 & 1879.
♀, 1 juv. (M. C. Z. 3250, 3253) Kulu Valley (M. M. Carleton) 1872.
4 skulls (M. C. Z. 44230–3) near Ambala (M. M. Carleton) 1879.
♀ (M. C. Z. 7201) Calcutta (N. Annandale) 1908.
♂, 2 juv. (M. C. Z. 7638) Tista Valley, Sikkim (T. Barbour) 1907.
2 juv. (M. C. Z. 7639) Calcutta (T. Barbour) 1907.
♂ (M. C. Z. 19630) Tellicherry (Basel Mus.) 1924.

Upper labials 10–13 (13 on one side only in two examples); gular scales in several adult males (including M. C. Z. 1334) almost devoid of keels; midbody scale-rows 36–48 (36 in M. C. Z. 8322 only), mostly 44–45. Total length of ♂ (M. C. Z. 1334), 455 (126 + 329) mm.

### Calotes maria Gray

*Calotes maria* Gray (part), 1845, Cat. Liz. Brit. Mus., p. 243: "Afghanistan" and Khasi Hills, Assam, India.

♀ topotype (M. C. Z. 7203) Cherrapunji, Khasi Hills (Lt. Bourne) 1908.

Midbody scale-rows 57–59. Total length of ♀, 386 (97 + 289) mm.

### Calotes jerdoni Günther

*Calotes jerdoni* Günther, 1870, Proc. Zool. Soc. London, p. 778, pl. xlv, fig. A: Khasi Hills, Assam, India.

♂ (M. C. Z. 7204) Assam (Assam Government) 1908.

Midbody scale-rows 55; light colored dorso-lateral stripes very distinct. Total length of ♂, 218 (60 + 158) mm.

### Calotes mystaceus Duméril & Bibron

*Calotes mystaceus* Duméril & Bibron, 1837, Erpét. Gén., **4**, p. 408: Burma.

♂ (M. C. Z. 3117) Calcutta (W. Theobald) 1866.

Midbody scale-rows 49; gular scales rather strongly keeled and mucronate; gular pouch quite large and of a dark purplish color, chiefly on the interstitial skin. Head and back more or less uniform and almost without the spots and lines stated by Dr. Smith (1935, p. 198) to be usually present on the head and flanks. Total length of ♂, 285 (110 + 175) mm.

The locality is probably erroneous as has been previously pointed out in regard to material received from Theobald.

### Calotes elliotti Günther

*Calotes elliotti* Günther, 1864, Rept. Brit. India, p. 142: Malabar, India.

♂, ♀, 2 juv. (M. C. Z. 6207) Anaimalai Hills at 4,700 feet (Brit. Mus.) 1888.

Midbody scale rows 57–59; both ♂ and ♀, particularly the latter, are of interest in that the spine on the supercilium is exceedingly minute and the suborbital white spot in one has become depressed and diffused, resulting in a yellowish white upper lip. These lizards are almost intermediate between *C. elliotti* and *C. rouxii*. The ♀, which holds two eggs each about 15 mm. in diameter, is unusually large. Total length of ♀, 262 (71 + 191) mm.

### Psammophilus dorsalis dorsalis (Gray)

*Agama dorsalis* Gray, 1831, App. p. 56 in Griffith, Anim. King.: India.

♂ (M. C. Z. 7209) Coonoor, Nilgiri Hills (F. Day) 1908.

Midbody scale rows 142–146; dorsals scarcely keeled or imbricate; hind limb reaches the orbit; tail swollen at base with the vertebral scales enlarged. Total length of ♂, 226 (82 + 144) mm.

### Psammophilus dorsalis blanfordanus (Stoliczka)

*Charasia blanfordana* Stoliczka, 1871, Proc. Asiatic Soc. Bengal, p. 194, and 1872, Journ. Asiatic Soc. Bengal, **41**, p. 110, pl. iii, fig. 5: Central India.

♂ (M. C. Z. 4112) Nilgiri Hills (E. Gerrard) 1877.
♀ (M. C. Z. 7210) Chanda, C. P. (W. T. Blanford) 1908.

I consider it advisable to regard *P. d. blanfordanus* as a subspecies of *P. d. dorsalis* for, on the basis of our three specimens, admittedly a very small series, it seems most unlikely that the differences between *dorsalis* and *blanfordanus* are sufficient to justify their ranking as full species. Their very close relationship is particularly noticeable in M. C. Z. 4112 which combines the larger scales and deep antehumeral fold of *blanfordanus* with the shorter hindlimbs and absence of enlarged scales on the flank usually found in *dorsalis*.

Midbody scale-rows 88–93; dorsals keeled and imbricate; superciliary spine and enlarged scales on the flanks present in the ♀, absent in the ♂; hindlimb reaching just beyond the orbit in the ♀ but barely past the tympanum in the ♂, this latter condition is characteristic of *dorsalis* according to Smith (1935, p. 209); base of tail in ♂ greatly swollen and all the scales much enlarged and thickened. Total length of ♂, 193 (71 + 122) mm.

### Agama himalayana (Steindachner)

*Stellio himalayanus* Steindachner, 1867, Reise Novara, Rept., p. 22, pl. i, fig. 8: Ladakh Province, Kashmir, India.

♀ topotype (M. C. Z. 7216) Ladakh, Kashmir (W. T. Blanford) 1878?

Upper labials 11; dorsal scale-rows 8–10. The stomach contains small black seeds. Total length of ♀, 194 (69 + 125) mm.

### Agama tuberculata Gray

*Agama tuberculata* Gray, 1827, Zool. Journ., **3**, p. 218, and 1830–5, Illus. Indian Zool., **2**, pl. lxxiii: "Bengal."

♂ ♂, 3 ♀ ♀ (M. C. Z. 2055) Kulu Valley (M. M. Carleton) 1870.
2 juv. (M. C. Z. 3145, 3426) Kulu Valley (M. M. Carleton) 1871.
10 eggs (M. C. Z. 4295) Kulu Valley (M. M. Carleton) 1877.

Upper labials 10–13. Total length of an unusually large ♂, (M. C. Z. 2055) 290+ (125 + 165+) mm., the tail being incomplete.

Of these lizards the Rev. M. M. Carleton writes that they "abound in the sub- and mid-Himalayas, but are not found in the plains or low hills. They live in old stone walls, ledges of loose rocks and often frequent the walls of native houses in the hills, but never intrude within the house like the common house lizard. They are preyed upon by house cats and the large hill snake. The young of this lizard are eaten by the large hill crow. This lizard at some seasons of the year is nearly covered with lice or a large parasite resembling sheep ticks . . . these parasites appear only later in the season."

The ten eggs, which measure from 24 × 15 mm. to 23 × 14 mm. were originally identified as those of *Calotes versicolor*. However, a careful examination of the well developed embryo shows that they are apparently the eggs of *Agama tuberculata*.

### Agama agrorensis (Stoliczka)

*Stellio agrorensis* Stoliczka, 1872, Proc. Asiatic Soc. Bengal, p. 128: Sussel Pass, Hazara District, northwest Punjab, India.

♀ (M. C. Z. 7217) Kashmir (Indian Mus.) 1908.

Dorsal scales in two strips 5–6 scales wide, separated by a vertebral series of small scales about 3 rows wide, towards the occiput the dorsal strips converge to form a single row of enlarged scales; hind limb reaches only just beyond the tympanum (not to the eye or tip of snout as described by Smith, 1935, p. 216). There are three very distinct, dark olive, longitudinal lines on the back which become paler posteriorly. Total length of ♀, 226 (74 + 152) mm.

### Agama melanura (Blyth)

*Laudakia* (*Plocederma*) *melanura* Blyth, 1854, Journ. Asiatic Soc. Bengal, 23, p. 738: ? Salt Range, Punjab, India.

♂, juv. (M. C. Z. 7218–9) Sind (J. A. Murray) 1908.

Dorsal scales strongly keeled in both examples. The juvenile shows well defined dark reticulations on the rather pale olive back and flanks. Its stomach contains the remains of flowers and what appear to be fragments of insects. Total length of ♂ (M. C. Z. 7218), 397 (115 + 282) mm.

### Agama nupta de Filippi

*Agama nupta* de Filippi, 1843, Giorn. Ist. Lomb. Bib. Ital., **6**, p. 407: Persepolis, Persia.

♂ (M. C. Z. 7220) Baluchistan (W. T. Blanford) 1908.

Median nuchal crest barely noticeable; callous preanal scales mostly in two rows; chest and limbs almost black (apparently a seasonal coloration according to Dr. Smith, 1935, p. 220). The stomach contains flowers, flies, and other insect remains. Total length of ♂, 390+ (156 + 234+) mm., the tail being partly regenerated.

### Agama agilis Olivier

*Agama agilis* Olivier, 1807, Voy. Emp. Otho., **4**, p. 394, and Atlas (12), pl. xxix, fig. 2: neighborhood of Baghdad, Persia.

juv. (M. C. Z. 7212) Sind (Indian Mus.) 1908.

Hindlimb reaches almost to the nostril; a very distinct vertebral and two faint lateral series of light colored oval spots crossing the dark crossbars. Total length of juv., 157 (67 + 90) mm.

### Agama rubrigularis (Blanford)

*Trapelus rubrigularis* Blanford, 1875, Proc. Asiatic Soc. Bengal, p. 233, and 1876, Journ. Asiatic Soc. Bengal, **45**, p. 23, pl. i, fig. 1: foot of the Khirthar Hills, Western Sind, India.

juv. (M. C. Z. 7213) Sind (J. A. Murray) 1908.

Although young, this lizard shows a row of 12 preanal pores with a few more forming an anterior series, which appear to be secretory. Total length, 84 (41 + 43) mm.

### Agama minor Hardwicke & Gray

*Agama minor* Hardwicke & Gray, 1827, Zool. Journ., **3**, p. 218: "Chittagong", India.

♀ (M. C. Z. 7211) Kathiawar (F. Fedden) 1908.

Midbody scale-rows 56. Total length of ♀, 103 (56 + 47) mm.

### Phrynocephalus scutellatus (Olivier)

*Agama scutellata* Olivier, 1807, Voy. Emp. Otho., **3**, p. 110 (ed. 4), **5**, p. 196 (ed. 8), and Atlas, pl. xlii, fig. 1: near Ispahan, Persia.

♀ (M. C. Z. 7221) Baluchistan (F. P. Maynard & A. H. MacMahon) 1908.

Outside edges of third and fourth toes only feebly denticulate; hind limb reaches the snout (not "about the level of the eye" as in Smith, 1935, p. 230). Total length of ♀, 98 (40 + 58) mm.

### Phrynocephalus theobaldi Blyth

*Phrynocephalus theobaldi* Blyth, 1863, Journ. Asiatic Soc. Bengal, **32**, p. 90: Lake Tsho-marari, Rupshu Province, Tibet.

♀ (M. C. Z. 4153) India (E. Gerrard) 1877.
♂, ♀ (M. C. Z. 7222–3) Indus Valley, Ladakh, Kashmir (F. Stoliczka) 1908.

Hind limb of the ♂ reaches the eye (to the axilla or region of the ear is characteristic according to Dr. Smith, 1935, p. 231). In M. C. Z. 7223 the black patch on the belly is very extensive, covering most of the throat as well as the abdomen. Total length of ♀ (M. C. Z. 7223), 113 (53 + 60) mm.

### Phrynocephalus ornatus Boulenger

*Phrynocephalus ornatus* Boulenger, 1887, Cat. Liz. Brit. Mus., **3**, p. 496: between Nushki and the Helmand River, Afghan-Baluchistan frontier.

♀ (M. C. Z. 7224) Baluchistan (F. P. Maynard & A. N. MacMahon) 1908.

Only 3 transverse bars on underside of tail (4 or 5 are constant for this species according to Dr. Smith, 1935, p. 233). Total length of ♀, 85 (36 + 49) mm.

### Phrynocephalus maculatus Anderson

*Phrynocephalus maculatus* Anderson, 1872, Proc. Zool. Soc. London, p. 389: Awada, Shiraz, Persia.

♂ (M. C. Z. 7225) Baluchistan (F. P. Maynard & A. H. MacMahon) 1908.

Although, I believe, undoubtedly referable to *P. maculatus*, this specimen is unusual in having the nasal shields separated by 3 scales (1 or 2 being considered diagnostic by Dr. Smith, 1935, pp. 229 and 233); inner edges of the third and fourth toes show almost as much denticulation as the outside edges. Total length of this exceptionally large ♂, 233 (94 + 139) mm.

### Phrynocephalus euptilopus Alcock & Finn

*Phrynocephalus euptilopus* Alcock & Finn, 1896, Journ. Asiatic Soc. Bengal, **65**, p. 556: Darband, at 3,000 feet, Baluchistan, India.

♀ cotype (M. C. Z. **7227**) Afghan-Baluchistan frontier (F. P. Maynard & A. H. MacMahon) 1908.

The black spots on the head are symmetrically and elegantly arranged; there is a single black bar underneath the tail, anterior to the black tip; the tail length is not commonly less than that of the body. Total length of ♀, 94 (48 + 46) mm.

### Phrynocephalus luteoguttatus Boulenger

*Phrynocephalus luteoguttatus* Boulenger, 1887, Cat. Liz. Brit. Mus., **3**, p. 497: between Nushki and the Helmand River, Afghan-Baluchistan frontier.

♀ (M. C. Z. 7228) Baluchistan (F. P. Maynard & A. H. MacMahon) 1908.

Total length of ♀, 73 (37 + 36) mm.

### Uromastix hardwickii Gray

*Uromastix hardwickii* Gray, 1827, Zool. Journ., **3**, p. 219: Kanauj District, United Provinces, India.

3 ♂ ♂, 3 ♀ ♀ (M. C. Z. 2530) Kulu Valley (M. M. Carleton) 1870.
♂ (M. C. Z. 6839) No locality (T. Barbour) 1903.
? ♀ (M C Z 7230) Karachi (Karachi Mus.) 1908.

Femoral pores 12–16; the Kulu Valley series conform to the typical variety (longest specimen 217 + 84 mm.) with only a few enlarged scales, while the other two lizards have many enlarged dorsal scales and are larger. Total length of ♂ (M. C. Z. 6839), 400 (234 + 166) mm.

## CHAMAELEONIDAE

### Chamaeleo zeylanicus Laurenti

*Chamaeleo zeylanicus* Laurenti, 1768, Syn. Rept., p. 46: based on Seba, 1735, Thesauri, **1**, pl. lxxxii, fig. 3: Type locality unknown.

? ♂ (M. C. Z. 7950) Western Ghats near Bombay (T. Barbour) 1912.
♀ (M. C. Z. 38598) Bangalore (Indian Mus.) 1935.
♀ (M. C. Z. 38599) Madras (Indian Mus.) 1935.
♀ (M. C. Z. 39895) Teynampet, Madras (Madras Mus.) 1936.
♂ ♂, ♀ (M. C. Z. 39896–8) Madras (Madras Mus.) 1936.

The generic name *Chamaeleo* Laurenti, 1768, is used in preference to *Chamaeleon* Gronow, allegedly 1763, because of Opinion 89 of the International Rules of Zoological Nomenclature which "declared eliminated from consideration as respects their systematic names as of their respective dates: Gronow 1763, . . . "

Both M. C. Z. 38598–9 are gravid, the former with 12 slightly developed ova, the latter with 17 eggs each about 11 mm. in diameter. Total length of ♀ (M. C. Z. 38598), 360 (165 + 195) mm.

## SCINCIDAE

### Mabuya bibronii (Gray)

*Tiliqua bibronii* Gray, 1838, Ann. Mag. Nat. Hist., **2**, p. 290: Type locality unknown.

1 (M. C. Z. 3925) Madras (R. H. Beddome) 1876.
1 (M. C. Z. 7170) Temple of Rameswaran, Pamban Island, Madras. (N. Annandale) 1908.

Midbody scale-rows 28–30; lamellae under fourth toe 18 in M. C. Z. 3925 while M. C. Z. 7170 had lost all its claws in life since the stumps are completely healed. Total length of M. C. Z. 7170, 110 (47+63) mm.

### Mabuya macularia (Blyth)

*Euprepes macularius* Blyth, 1853, Journ. Asiatic Soc. Bengal, **22**, p. 652: ?Rangpur, Bengal, India.

6 (M. C. Z. 3926) Madras (R. H. Beddome) 1876.
1 (M. C. Z. 7173) Ellora, Hyderabad (W. T. Blanford) 1908.

Midbody scale-rows 28–30; lamellae under fourth toe 14–16. In coloration the Madras series mostly conform to typical South Indian skinks corresponding to Form 1 of M. A. Smith (1935, p. 265) though distinct lateral stripes are lacking in two of them which consequently approach Form 2 characteristic of North India. The Ellora specimen, though faded, apparently agrees with Form 2. Total length of M. C. Z. 3926, 147 (65 + 82) mm.

### Mabuya carinata (Schneider)

*Scincus carinatus* Schneider (part), 1801, Hist. Amphib., **2**, p. 183: Type locality unknown.

1 (M. C. Z. 3919) Madras (R. H. Beddome) 1876.
1 (M. C. Z. 7172) Botanical Gardens, Sibpur, Bengal (J. Anderson) 1908.
2 (M. C. Z. 7660) Calcutta (T. Barbour) 1907.

Midbody scale-rows 30–32; lamellae under fourth toe 15–17; both the Barbour specimens are atypical in having the prefrontals definitely separated. Total length of M. C. Z. 7660, 211 (85 + 126) mm.

### Mabuya multifasciata multifasciata (Kuhl)

*Scincus multifasciatus* Kuhl, 1820, Beitr. Zool. Vergl. Anat., p. 126: Type locality unknown.

1 (M. C. Z. 3118) Calcutta (W. Theobald) 1864.

Midbody scale-rows 30; lamellae under fourth toe 16–17. Total length, 259 (100 + 159) mm.

### Mabuya beddomii (Jerdon)

*Euprepes beddomii* Jerdon, 1870, Proc. Asiatic Soc. Bengal, p. 73: Mysore, India.

1 (M. C. Z. 7171) Berar (J. Anderson) 1908.

Midbody scale-rows 30; lamellae under fourth toe 13–15. Total length, 121 (52 + 69) mm.

### Mabuya trivittata (Hardwicke & Gray)

*Tiliqua trivittata* Hardwicke & Gray, 1827, Zool. Journ., **3**, p. 227, and 1829, Illus. Indian Zool., **2**, pl. lxxvi: Dum-Dum, Bengal, India.

1 (M. C. Z. 8362) 70 miles s. w. of Ambala (M. M. Carleton) 1879.

Midbody scale-rows 36, the dorsals feebly tricarinate (instead of with 5 or 7 strong keels); lamellae under fourth toe 14-15. Total length, 140 (60 + 80) mm.

### Lygosoma (Sphenomorphus) indicum indicum (Gray)

*Hinulia indica* Gray, 1853, Ann. Mag. Nat. Hist. (2), **12**, p. 388: Himalayas, India.

1 (M. C. Z. 7176) Darjeeling (J. Gammie) 1908.

Midbody scale rows 35; lamellae under fourth toe 19. Total length, 179 (85 + 94) mm., but tail regenerated.

### Lygosoma (Sphenomorphus) maculatum (Blyth)

*Lissonota maculata* Blyth, 1853, Journ. Asiatic Soc. Bengal, **22**, p. 653: Assam, India.

1 (M. C. Z. 7177) Darjeeling (J. Gammie) 1908.

Midbody scale-rows 40; lamellae under fourth toe 18. Total length, 141 (56 + 85) mm.

### Lygosoma (Sphenomorphus) dussumieri Duméril & Bibron

*Lygosoma dussumieri* Duméril & Bibron, 1839, Erpét. Gén., **5**, p. 725: Malabar, India.

2 (M. C. Z. 3924) Madras (R. H. Beddome) 1876.

Midbody scale-rows 40, the dorsals considerably larger than the laterals thus approaching the condition of *L.* (*S.*) *maculatum;* lamellae under fourth toe 21–22. Total length, 131 (50 + 81) mm.

### Lygosoma (Leiolopisma) reevesii reevesii (Gray)

*Tiliqua reevesii* Gray, 1838, Ann. Mag. Nat. Hist., **2**, p. 292: China.

1 (M. C. Z. 3119) Calcutta (W. Theobald) 1866.

Midbody scale-rows 22; lamellae under fourth toe 18–19. This skink, apparently the first of its species to be recorded from India proper, differs in some respects from the description of the typical form given by M. A. Smith (1935, p. 296); the distance between the end of the snout and the forelimb is contained once and a quarter (not once and a half to nearly twice) in the distance between the axilla and groin; the limbs are rather longer, the adpressed hindlimb reaching practically to the elbow of the forelimb (not just failing to meet or reaching as far as the wrist). In coloration the black stripe along the upper half of the flank is broken up to form a row of dark splotches. This specimen was identified as *Lygosoma* (*Sphenomorphus*) *maculatus* by Theobald, consequently *reevesii* was omitted from his 1876, *Descriptive Catalogue of the Reptiles of British India.* Total length, 106 (43 + 63) mm.

### Lygosoma (Leiolopisma) himalayanum (Günther)

*Eumeces himalayanus* Günther, 1864, Rept. Brit. India, p. 86, pl. x, fig. H: Western Himalayas, India.

1 (M. C. Z. 3154) Ambala (M. M. Carleton) 1873.
9 (M. C. Z. 3240–1, 3247, 3249, 4064) Kulu Valley (M. M. Carleton) 1871 & 1876.

Midbody scale-rows 26–30 (32 in M. C. Z. 3249); lamellae under fourth toe 14–17 (19–20 in M. C. Z. 3249). Three lizards in this series are of especial interest in being intermediate between *L.* (*L*) *himalayanum* and *L.* (*L*) *ladacense*. M. C. Z. 3154 and one of the M. C. Z. 3240 series are typically *himalayanum* except in that the distance between the tip of the snout and the axilla is *not* contained 1½–1¾ times in the distance from axilla to groin as in *himalayanum*, but 1⅓–1½ times as in *ladacense*, with which they also agree in the adpressed hindlimb reaching the wrist instead of failing to meet or just overlapping as in *himalayanum*.

Additional intermediate characters are displayed by M. C. Z. 3249 in which the prefrontals are just in contact, a condition normal in *ladacense* but rare in *himalayanum*; its midbody scale-rows are 32 (26–30 in *himalayanum*, 32–38 in *ladacense*) while the lamellae under

the fourth toe number 19–20 (14–20 in *himalayanum*, 20–24 in *ladacense*). These three aberrant skinks, especially M. C. Z. 3249, seem similar to the types of *L.* (*L*) *blythi* as described by M. A. Smith (1935, p. 300) who refers them to the synonomy of *himalayanum* and further suggest that perhaps *ladacense* should be only subspecifically distinguished from *himalayanum*.

With the Kulu lizards is a rather illegible manuscript note by the collector stating that they were collected near Ploch (?) village in the eastern part of Kulu Valley in August, 1871. Total length of M. C. Z. 3247, 147 (71 + 76) mm.

### Lygosoma (Leiolopisma) himalayanum tragbulense Alcock

*Lygosoma himalayanum* var. *tragbulense* Alcock, 1898, Rep. Nat. Hist. Results Pamir Bound. Comm., p. 36, pl. ii: Tragbul (as Tragbal) Pass, Kashmir, India.

paratype (M. C. Z. 7181) Tragbul Pass, Gilgit Road (G. M. Giles) 1908.

I have been unable to find the Tragbul Pass on any map, but the Royal Geographical Society informs me that it lies in Lat. 34° 29′N., Long. 74 40′ E., 30 miles N.N.W. of Srinagar, and is therefore in Kashmir, rather than Afghanistan, so falls within the area covered by this report though this subspecies is not mentioned in Dr. Malcolm Smith's volume on the lizards of British India (1935).

Midbody scale rows 26; lamellae under fourth toe 18–19 (21 in the original description). In coloration our paratype of this rare skink conforms perfectly to Alcock's illustration, showing 6 very clearly defined, longitudinal, dorsal, whitish stripes and the flanks flecked with whitish. Alcock apparently included these lateral markings as stripes for he describes the types as having 10 or 11 dorsal stripes. Total length 110 (50 + 60) mm.

### Lygosoma (Leiolopisma) ladacense (Günther)

*Eumeces ladacensis* Günther, 1864, Rept. Brit. India, p. 88, pl. x, fig. 1: Ladakh. Kashmir, India.

topotype (M. C. Z. 7182) Kharu, Ladakh (F. Stoliczka) 1908.

Midbody scale-rows 36; lamellae under fourth toe 20. Total length, 134 (49 + 85) mm.

### Lygosoma (Leiolopisma) sikkimense (Blyth)

*Mocoa sikkimensis* Blyth, 1853, Journ. Asiatic Soc. Bengal, **22**, p. 652: Sikkim. India.

1 (M. C. Z. 7179) Saoreni, near Darjeeling (A. W. Alcock) 1908.

Midbody scale-rows 24; lamellae under fourth toe 15. Total length, 98 (48 + 50) mm., but tail regenerated.

### Lygosoma (Leiolopisma) travancoricum (Beddome)

*Mocoa travancorica* Beddome (part), 1870, Madras Month. Journ. Med. Sci., p. 34: Travancore Hills, India.

1 (M. C. Z. 6216) Anaimalai Hills, at 4,700 feet (Brit. Mus.) 1888.

Midbody scale-rows 24; lamellae under fourth toe 18–19. Total length, 153 (54 + 99) mm.

### Lygosoma (Leiolopisma) bilineatum bilineatum (Gray)

*Mocoa bilineatum* Gray, 1846, Ann. Mag. Nat. Hist., **18**, p. 430: Nilgiri Hills, India.

2 topotypes (M. C. Z. 4130) Nilgiri Hills (E. Gerrard) 1879.
1 (M. C. Z. 7183) No locality (R. H. Beddome) 1908.

Midbody scale-rows 24; lamellae under fourth toe 17–19; distance between end of snout and forelimb is contained scarcely one and one-third times in the distance between axilla and groin in the juvenile topotype (M. C. Z. 4130) instead of the one and a half to twice usual in this subspecies (Smith, 1935, p. 306). My reasons for employing trinomials are explained below. Total length of M. C. Z. 7183, 135 (50 + 85) mm.

### Lygosoma (Leiolopisma) bilineatum laterimaculatum Boulenger

*Lygosoma laterimaculatum* Boulenger, 1887, Cat. Liz. Brit. Mus., **3**, p. 260, pl. xviii, fig. 2: Sivagiri Ghat, Tinnevelly, India.

6 (M. C. Z. 3923, 4782) near Madras (R. H. Beddome) N. D.

All six lizards are more or less intermediate between *L.* (*L.*) *bilineatum* and *L.* (*L*) *laterimaculatum* as defined by Malcolm Smith (1935, pp. 305–6), but I consider them closer to *laterimaculatum* since they agree with it in the important characters of midbody scale-rows and coloration. A tabular exposition of the characters follows:

| Character | *bilineatum* as in Smith | *laterimaculatum* as in Smith | M. C. Z. material |
|---|---|---|---|
| Midbody scale-rows | 22–26 | 26–28 | 26–28 |
| Times the distance between end of snout and forelimb is contained in that from axilla to groin | 1½–2 | 1⅛–1⅓ | 1⅛–1⅔ |
| Lobules on ear-opening | 2 or 3 very small ones. | sometimes a few granules but no lobules. | always a few granules, usually a few very small lobules. |
| Preanals | 4 large ones longer than broad. | 2 large ones broader than long. | 2 large ones and 2 slightly enlarged, most broader than long, a few longer than broad. |
| Adpressed limbs | overlap in the young, fail to meet in adult. | leg reaches to wrist or elbow. | fail to meet in two, just meet in two, leg nearly reaches wrist in two. |
| Lamellae under fourth toe | 16–20 | 20–25 | 17–21 (21 in one skink only) |
| Color | sides not spotted with black. | sides spotted with black. | sides spotted with black. |
| Size: snout to vent | 65 mm. | 36 mm. | 30, 46, 50, 52, 56, & 69 mm. |

Thus of the eight diagnostic characters listed, our specimens tend to agree with *bilineatum* in four, with *laterimaculatum* in two, and to be intermediate in two. As the relationship appears to be subspecific rather than specific I employ trinomials. Total length of M. C. Z 3923, 183 (69 + 114) mm.

### Riopa punctata (Gmelin)

*Scincus punctatus* Gmelin, 1799, Hist. Amphib., p. 197, based on Seba, 1735, Thesauri, **1**, pl. xii, fig. 6: Type locality unknown.

15 (M. C. Z. 3238, 3748) 70 miles s. w. of Ambala (M. M. Carleton) 1872–4.
3 (M. C. Z. 3243) Bengal (M. M. Carleton) 1872.
13 (M. C. Z. 3928) Madras (R. H. Beddome) 1876.
1 (M. C. Z. 7184) Kolassy, Purnea (J. Anderson) 1908.

Midbody scale-rows 24–26; dorsal scales between the parietals and an imaginary line joining the hind limbs posteriorly 69–76 with 66

in one example; lamellae under fourth toe 11–15 (11–14 given by M. A. Smith, 1935, p. 318); upper labials 6, fourth longest and beneath the eye in one Ambala skink and on one side only of another, otherwise the normal 7 upper labials with the fifth longest as described by M. A. Smith.

In the eight youngest skinks (from all localities) the body is less elongated than in the adult, the distance between the end of the snout and the forelimb being contained in the distance between the axilla and groin less than twice (twice to two and three quarter times being normal). Total length of M. C. Z. 3928, 142 (68 + 74) mm.

M. C. Z. 7184 was received as *R. albopunctata* (Gray) and agrees with Dr. Smith's (1935, p. 316) description of that species in having a scaly lower eyelid. Since, however, this character appears variable in *Riopa*, and the other features distinguishing *albopunctata* from *R. punctata* are rather trivial, I doubt whether *albopunctata* should be considered as distinct.

### Riopa guentheri (Peters)

*Eumeces guentheri* Peters, 1879, Sitzb. Ges. Naturf. Freunde Berlin, p. 36: East India as "Ostindien."

1 (M. C. Z. 4131) S. Kanara Ghats, Bombay (E. Gerrard) 1877.
1 (M. C. Z. 7186) Travancore (R. H. Beddome) 1908.

Midbody scale-rows 24–26; dorsal scales between the parietals and an imaginary line joining the hind limbs posteriorly 90–91; lamellae under fourth toe 12. Total length of M. C. Z. 7186, 172 (100 + 72) mm., but tail regenerated.

### Ristella travancorica (Beddome)

*Ateuchosaurus travancoricus* Beddome (part), 1870, Madras Month. Journ. Med. Sci., p. 33: Western Ghats, India.

1 (M. C. Z. 7190) Tinnevelly Hills (R. H. Beddome) 1908.

Midbody scale-rows 24; throat handsomely marked with 9 rows of almost confluent, dark brown spots. Total length 76+ (42 + 34+)mm.

### Ristella beddomii Boulenger

*Ristella beddomii* Boulenger, 1887, Cat. Liz. Brit. Mus., **3**, p. 359, pl. xxix, fig. 4, and 1890, Fauna Brit. India, p. 216: Southwest India.

2 topotypes (M. C. Z. 3921) Southwest India (R. H. Beddome) 1876.

Midbody scale-rows 26; the adpressed limbs fail to meet in these young examples. It seems probable that these topotypes were originally part of the series collected by Col. Beddome of which some became the types of Boulenger's new species. Total length of larger lizard, 45+ (35 + 10+) mm.

### Eumeces taeniolatus (Blyth)

*Eurylepis taeniolatus* Blyth, 1854, Journ. Asiatic Soc. Bengal, **23**, p. 470: Salt Range, Punjab, India.

2 (M. C. Z. 4370, 4493) near Ambala (M. M. Carleton) 1878 & 1880.

1 (M. C. Z. 7192) Karachi (Indian Mus.) 1908.

Midbody scale-rows 19–21, 19 in M. C. Z. 4370 appears to be unusual as 21–23 is the range given by M. A. Smith (1935, p. 342); dorsal scales in longitudinal series 72–74. Total length of M. C. Z. 4370, 268+ (132 + 136+) mm.

### Ophiomorus tridactylus (Blyth)

*Sphenocephalus tridactylus* Blyth, 1853, Journ. Asiatic Soc. Bengal, **22**, p. 654: Afghanistan.

1 (M. C. Z. 7193) Baluchistan (F. P. Maynard & A. H. MacMahon) 1908.

Midbody scale-rows 20 instead of 22, a condition otherwise known only from a single Punjab example according to Dr. Smith (1935, p. 347). Total length, 140 (91 + 49) mm.

## LACERTIDAE

### Acanthodactylus cantoris cantoris Günther

*Acanthodactylus cantoris* Günther, 1864, Rept. Brit. India, p. 73: Ramnagar, India.

♀ (M. C. Z. 7159) Karachi (Karachi Mus.) 1908.

Midbody dorsals in 31 longitudinal rows, enlarged dorsals in 16; ventrals in 12; transverse rows of ventrals 30; transverse rows of gulars 30; femoral pores 18 on each side. Total length of ♀, 178 (66 + 112) mm.

### Cabrita leschenaultii (Milne-Edwards)

*Lacerta leschenaultii* Milne-Edwards, 1829, Ann. Sci. Nat. Paris, **16**, pp. 80, 86, pl. vi, fig. 9: Coromandel Coast, India.

♂, ♀, juv. (M. C. Z. 3922) Madras (R. H. Beddome) N. D.
juv. (M. C. Z. 4137) Ganjam (E. Gerrard) 1877.
juv. (M. C. Z. 7161) Ellora (W. T. Blanford) 1908.

Midbody scale-rows 40–54 (42–50 is given for this species by M. A. Smith, 1935, p. 375); transverse rows of ventrals 24–28; femoral pores 12–16 on each side; one lizard (M. C. Z. 4137) shows the unusual condition of having the fourth (rather than the fifth) upper labial enlarged and below the eye. Total length of ♂, 149 (49 + 100) mm.

### Ophisops jerdoni (Blyth)

*Ophiops jerdoni* Blyth, 1853, Journ. Asiatic Soc. Bengal, **22**, p. 653: Mhow, Indore, Central Provinces, India.

♂ (M. C. Z. 7160) Agra (P. Hodgart) 1908.
juv. (M. C. Z. 7162) Cutch (Indian Mus.) 1908.

Midbody scale-rows 28–30; transverse rows of ventrals 24; femoral pores 8–10 on each side; one lizard (M. C. Z. 7160) is unusual in lacking any properly developed tympanic shield, commonly present in this species. Total length of ♂, 103 (40 + 63) mm.

### Ophisops microlepis (Blanford)

*Ophiops* (*Gymnops*) *microlepis* Blanford, 1870, Journ. Asiatic Soc. Bengal, **39**, p. 351, pl. xv, figs. 1–5: Korba, Bilaspur, Central Provinces, India.

♂ (M. C. Z. 7163) Cutch (Indian Mus.) 1908.

Midbody scale-rows 59; transverse rows of ventrals 25; femoral pores 12 on each side. Total length of ♂, 156 (55 + 101) mm.

### Eremias velox persica Blanford

*Eremias persica* Blanford, 1874, Ann. Mag. Nat. Hist. (4), **14**, p. 370: near Ispahan, Persia.

♀ (M. C. Z. 7165) Quetta, Baluchistan (Col. St. John) 1908.

Midbody dorsals 58; midbody ventrals 14; transverse rows of ventrals 30; transverse rows of gulars 32; femoral pores 18 on each side; the 8th (instead of the 7th) upper labial is below the eye on one side. Total length of ♀, 203 (80 + 123) mm.

### Eremias aporosceles (Alcock & Finn)

*Scapteira aporosceles* Alcock & Finn, 1896, Journ. Asiatic Soc. Bengal, **65**, p. 559, pl. xiii: West of Robat 1, near Nushki, Baluchistan, India.

♂ cotype (M. C. Z. 7169) West of Robat 1 (F. P. Maynard & A. H. MacMahon) 1895.

Midbody dorsals 76; midbody ventrals 20; transverse rows of ventrals 36; transverse rows of gulars 33; femoral pores absent. Total length of ♂, 165 (63 + 102) mm.

### Eremias guttulata watsonana Stoliczka

*Eremias* (*Mesalina*) *watsonana* Stoliczka, 1872, Proc. Asiatic Soc. Bengal, p. 86: between Karachi and Sukkur, Sind, India.

♀ (M. C. Z. 7164) Gwadar, Baluchistan (W. T. Blanford) 1872.

Midbody dorsals 47; midbody ventrals 8; transverse rows of ventrals 32; transverse rows of gulars 24; femoral pores 11 on each side. Total length of ♀, 102 (41 + 61) mm.

## ANGUIDAE

### Ophisaurus gracilis (Gray)

*Pseudopus gracilis* Gray, 1845, Cat. Liz. Brit. Mus., p. 56: Khasi Hills, Assam, India.

topotype (M. C. Z. 7231) Cherrapunji, Khasi Hills (Capt. Godwin-Austen) 1908.

Midbody dorsals 14; transverse rows of dorsals counted in the length of the dorsal fold 92; midbody ventrals 10. The coloration is unusual in that the dark lateral band is almost lacking except on the tail where it is indistinct; the transverse rows of dark spots are more or less fused to form 20 crossbars on the body, each covering from

7–10 dorsal scales; the tail shows the more common dark spots or splotches. Total length, 274 (139 + 135) mm, but the tail is regenerated.

## VARANIDAE

### Varanus bengalensis bengalensis (Daudin)

*Tupinambis bengalensis* Daudin, 1802, Hist. Nat. Rept., **3**, p. 67: Bengal, India.

juv. (M. C. Z. 2119) Bengal (Paris Mus.) 1865.
juv. (M. C. Z. 3199) Northern India (M. M. Carleton) 1873.
2 skins (M. C. Z. 3231–2) Bengal (M. M. Carleton) 1871.
3 juv. (M. C. Z. 3745, 8307–8) near Ambala (M. M. Carleton) 1873–4.
juv. (M. C. Z. 4127) Malabar (E. Gerrard) 1877.

Transverse rows of abdominal scales from gular fold to anus 122–136. Total length of largest skin (M. C. Z. 3232), 760 (420 + 340) mm.

In a manuscript note accompanying the Ambala specimens the collector states that these monitors "live in old trees and are found during the cold season in the hollows of the trees and branches. It attains the size of 36 inches or more. It is the great enemy of birds that build their nests in trees."

For the nomenclature of this species I have followed Robert Mertens, 1942, "Die Familie der Warane (Varanidae), III. Taxonomie." in Abhand. Senckenberg. Naturf. Ges., No. 466, pp. 237–391.

## TYPHLOPIDAE

### Typhlops loveridgei spec. nov.

*Type.* Museum of Comparative Zoölogy, No. 2283, probably from North India since received from the Rev. M. M. Carleton in 1873. Most of Carleton's collections came from Ambala or the Kulu Valley, Punjab, but this snake was donated with the poorly localized *T. d. diardi* listed below.

*Diagnosis.* Differs from *T. floweri* Boulenger, of Siam, in that the preocular is as broad as (not narrower than) the ocular, which is in contact with the third and fourth (not third only) labials; it also lacks the small semi-subocular of *floweri* which in that species sepa-

rates the ocular from the fourth labial. It further differs from *floweri* in range and color.

Differs from *T. porrecta* Stoliczka in having the preocular in contact with the third (not second and third) labial; nasal completely (not incompletely) divided; diameter of body 83 (not 49 to 60) times into the total length.

*Description.* Snout rounded, prominent; rostral breadth about two-fifths the width of the head, not extending to an imaginary line connecting the oculars; nostrils lateral; nasals separated behind the rostral, completely divided, the cleft proceeding from the preocular; the preocular as broad as the ocular and in contact with the third labial only; ocular in contact with the third and fourth labials; eye hidden; four upper labials. Midbody scale-rows 18. Diameter of body included 83 times in the total length. Tail ending in a point.

*Color.* Above, uniform light brown. Below, paler, especially around the mouth and anus.

*Size.* Total length of type, 208 mm.; head and body 204.5 mm.; tail 3.5 mm.; diameter at midbody 2.5 mm.

The following key can be used to distinguish the three forms:

Snout rounded; rostral one-third to one-half width of head; nasals separated behind rostral; midbody scale-rows 18.

1. Preocular narrower than ocular, in contact with second and third labials, ocular in contact with third labial only, being separated from fourth by a small semi-subocular; nasal completely divided; diameter of body 85 times in total length; range: Siam; color blackish with snout and anal region yellowish. . . . . *floweri*
   Preocular as broad as ocular; ocular in contact with third and fourth labials; color paler than in *floweri*. 2
2. Preocular in contact with third labial only; nasal completely divided; diameter of body 83 times in total length; range: ? northern India. . . . . *loveridgei*
   Preocular in contact with second and third labials; nasal incompletely divided; diameter of body 49–60 times in total length; range: Himalayas and Burma south to Ceylon (fide Malcolm Smith, 1943, p. 46), . . . . . *porrecta*

Though approaching *mira* and *ceylonica* the new species is not closely related to either.

*Remarks.* I take very great pleasure in naming this new *Typhlops* after Mr. Arthur Loveridge in appreciation of his generous help and as a token of personal esteem.

### Typhlops porrecta Stoliczka

*Typhlops porrectus* Stoliczka, 1871, Journ. Asiatic Soc. Bengal, **40**, p. 426, pl. xxv, figs. 1–4: Bengal, India.

6 (M. C. Z. 3135, 3142, 4066, 4802) Kulu Valley (M. M. Carleton) 1874–6.
1 (M. C. Z. 3750) plains 70 miles s. w. of Ambala (M. M. Carleton) 1874.

Midbody scale-rows 18; rostral breadth one-third to one-half the width of head; nasals not quite in contact, semidivided, the cleft proceeding from the first labial; midbody diameters 3–4.5 mm., included in total lengths 49–55 times. Total length of M. C. Z. 3135 229 (225.5 + 3.5) mm.

### Typhlops bramina (Daudin)

*Eryx braminus* Daudin, 1803, Hist. Nat. Rept., **7**, p. 279: Vizagapatam, India.

1 (M. C. Z. 2237) Malabar (Paris Mus.) 1865.
12 (M. C. Z. 3913–4) near Madras (R. H. Beddome) 1876.
2 (M. C. Z. 5229) Madras Coast (H. A. Ward) 1884.
6 (M. C. Z. 5393, 48775–9) plains s. w. of Ambala (M. M. Carleton) 1879.

Midbody scale-rows 20; rostral breadth one-quarter to one-third the width of head; nasals separated and divided, the cleft in contact with preocular except in M. C. Z. 3913, 3913A, and 5229A, where it reaches the second labial; midbody diameters 2–3.5 mm., included in total lengths 35–55 times. Total length of M. C. Z. 5229A, 169 (166 + 3) mm. The poorly preserved Malabar specimen has been excluded from examination.

Malcolm Smith (1943, p. 45) separates *bramina* and *T. psammeces* as follows:

Diameter of body 30–45 times into total length; transverse scale-rows on body 290–320 . . . . . *bramina*
Diameter of body 55–75 times into total length; transverse scale-rows on body 370–400 . . . . . *psammeces*

In the matter of diameter into length our series is clearly referable to *bramina*, but the transverse scale-rows range from 270–382 (approximately 270, 298, 299, 300, 306, 309, 312, 315, 316, 320, 323, 342, 382 in the Madras series alone) suggesting that this character is without significance for the separation of *psammeces*.

### Typhlops diardi diardi Schlegel

*Typhlops diardi* Schlegel, 1839, Abbild. Amphib., p. 39: Indes Orientales.

2 (M. C. Z. 2284) North India (M. M. Carleton) 1873.

Midbody scale-rows 24–25; rostral breadth about one-third the width of the head; nasals not in contact, semidivided, the cleft proceeding from the second labial; midbody diameters 9–12 mm., included in total lengths 28–30 times. Total length of larger snake, 376 (370 + 6) mm.

Most of the Rev. M. M. Carleton's specimens were carefully labeled and came from Ambala or the Kulu Valley region. These Punjab localities are far removed from Bengal, which is given by Smith as the most westerly point in the range of either form of *diardi*.

### Typhlops beddomii Boulenger

*Typhlops beddomii* Boulenger, 1890, Fauna Brit. India, Rept. Batr., p. 237: Hills of the Indian Peninsula between 2,000 and 5,000 feet.

2 (M. C. Z. 3929) near Madras (R. H. Beddome) N. D.
cotype (M. C. Z. 22372) Travancore Hills at 4,000 feet (R. H. Beddome) N. D.

Midbody scale-rows 18; rostral breadth one-third the width of the head; nasals broadly in contact, semidivided, the cleft proceeding from the second labial, separating the anterior nasal from the preocular; midbody diameters 3–3.5 mm., included in total lengths 31–33 times. Total length of cotype, 110 (106 + 4) mm.

This cotype of *beddomii* (not *beddomei* as given by Smith, 1943, pp. vii, 45, 54, etc.) was received in exchange from the British Museum in 1926. The two received direct from Beddome were entered as from "Madras," a blanket locality with little significance.

### Typhlops acuta (Duméril & Bibron)

*Onychocephalus acutus* Duméril & Bibron, 1844, Erpét. Gén., **6**, p. 333: Type locality unknown.

1 (M. C. Z. 3849) near Madras (R. H. Beddome) 1876.
1 (M. C. Z. 18033) Taliparamba, Madras (F. Wall) 1923.

Midbody scale-rows 30–32; rostral, breadth five-eighths to three-quarters the width of head, hooked; nasals widely separated, semi-

divided, the cleft proceeding from the second labial; midbody diameters 4–4.5 mm., included in total lengths 43–44 times. Total length of M. C. Z. 18033, 198 (195 + 3) mm.

## LEPTOTYPHLOPIDAE

### Leptotyphlops blanfordii (Boulenger)

*Glauconia blanfordii* Boulenger, 1890, Fauna Brit. India, Rept. Batr., p. 243, fig. 72: Sind, India.

*Glauconia carltoni* Barbour, 1908, Bull. Mus. Comp. Zool., **51**, p. 316: (70 miles s.w. of) Ambala, Punjab, India.

Type & 2 paratypes of *carltoni* (M. C. Z. 3749, 3217) 70 miles s. w. of Ambala (M. M. Carleton) 1864 & 1874.

Midbody scale-rows 18; snout rounded; rostral breadth one-third the width of head; nasal completely divided, bordering the lip; ocular also bordering the lip; midbody diameters 2–2.5 mm., included in total lengths 71–81 times. Total length of largest snake (a paratype), 179 (164 + 15) mm., the type only a millimetre smaller.

Though the author of *Glauconia carltoni* spelled the specific name without an "e," the collector's name was really Carleton, as shown by his signature affixed to a manuscript field note preserved with M. C. Z. 4369.

Dr. Barbour, when describing *carltoni*, suggests that it may be a race of *blandfordii* differentiated by stouter form as shown by a diameter that is included "55 times" in the total length. Before reading this, however, both Mr. Loveridge and I had independently measured the type and found its diameter to be 2.5 mm., and its length 173 or 179 mm., giving a diameter into length of 71 times, for the paratypes 71–81, as against Boulenger's 60–80 for the types of *blanfordii*. The range for the species should now read 60–81 times, amending Smith's (1943, p. 61) description.

## UROPELTIDAE

Of this family Dr. Malcolm A. Smith (1944, p. 61) states that a constant characteristic is the absence of a loreal and the presence of four upper labials. Though usual, neither are constant, as will be

seen from the following records of M. C. Z. material. I am heartily in agreement with the statement (p. 63) that, owing to the extreme brevity of the Uropeltid tails, the short hemipenes are difficult to examine satisfactorily. Where no count is given in the following pages for loreal, preocular, postocular, or temporals, these shields are absent.

### Melanophidium wynandense (Beddome)

*Plectrurus wynandensis* Beddome, 1863, Proc. Zool. Soc. London, p. 228: Wynaad Hills, 3,500 feet, Malabar District, India.

♂ topotype (M. C. Z. 24739) Wynaad Hills (Brit. Mus.) 1927.

Midbody scale-rows 17; ventrals 174; anals 2; subcaudals 12; upper labials 4. Total length of ♂, 397 (385 + 12) mm.

Beddome's original spelling of the specific name was *wynandensis*, not *wynaudensis* as given by Smith (1943) on pp. vii, 65, 67, and 583.

### Platyplectrurus madurensis Beddome

*Platyplectrurus madurensis* Beddome, 1877, Proc. Zool. Soc. London, p. 167: Palni Hills, India.

3 topotypes (M. C. Z. 18044–6) Shembaganur, Palni Hills (F. Wall) 1923.

Midbody scale-rows 15; ventrals 164–167; anals 2; subcaudals 10–14; upper labials 4; postocular 1; temporal 1. Total length of ♀, (M. C. Z. 18043), 321 (305 + 16) mm.

### Teretrurus sanguineus (Beddome)

*Plectrurus sanguineus* Beddome, 1867, Madras Quart. Journ. Med. Sci., 9, p. 14, pl. i, figs 1–2: Anaimalai Hills, India.

2 topotypes (M. C. Z. 6203) Anaimalai Hills, at 4,700 feet (Brit. Mus.) 1888.
1 (M. C. Z. 47900) near Madras (R. H. Beddome) N. D.

Midbody scale-rows 15; ventrals 129–144; anals 2; subcaudals 8–9; upper labials 4; postocular 1; temporal 1. Total length of ♀ (M. C. Z. 6203), 201 (194 + 7) mm.

The original description called for 17 scale-rows, but this has been attributed to a miscount.

### Teretrurus rhodogaster (Wall)

*Brachyophidium rhodogaster* Wall, 1921, Journ. Bombay Nat. Hist. Soc., **28**, p. 41: Palni Hills, India.

7 topotypes (M. C. Z. 18070–6) Shembaganur, Palni Hills (F. Wall) 1923.

Midbody scale-rows 15; ventrals 133–141; anals 2; subcaudals 7–11; upper labials 4; postocular 1; temporal 1. Total length of ♂ (M. C. Z. 18076), 195 (185 + 10) mm.

These counts somewhat increase the ventral range. The snakes are part of a series of 8 specimens listed as paratypes by Barbour & Loveridge (1929, Bull. Mus. Comp. Zoöl., 69, p. 229), but Wall had only a single ♀ holotype (now in the British Museum) which he believed to have come from the Palni Hills.

### Plectrurus perroteti Duméril & Bibron

*Plectrurus perroteti* Duméril & Bibron, 1854, Erpét. Gén., **7**, p. 167, pl. lix, fig. 4: Nilgiri Hills, India.

5 (M. C. Z. 3860, 3867, 3875 (2), 3915) near Madras (R. H Beddome) N. D.
♀ topotype (M. C. Z. 4178) Nilgiri Hills (E. Gerrard) 1877.
3 (M. C. Z. 6202) Anaimalai Hills (Brit. Mus.) 1888.

Midbody scale-rows 15; ventrals 144–173; anals 2; subcaudals 7–12; upper labials 3–4 (3 on right side only of M. C. Z. 4178). Total length of ♀ (M. C. Z. 4178), 282 (270 + 12) mm.

These counts decrease the ventral range from the previous low of 152 of Malcolm Smith. Duméril & Bibron state that some of their 15 to 20 cotypes were in the British Museum; whether our topotype, purchased from Gerrard, is one of this series seems very doubtful.

### Plectrurus canaricus (Beddome)

*Silybura canarica* Beddome, 1870, Madras Month. Journ. Med. Sci., **2**, p. 170: "Kudra Mukh" at 6,000 feet, India.

♂ topotype (M. C. Z. 24737) Kudremukh, at 6,200 feet (Brit. Mus.) 1927.

Midbody scale-rows 15; ventrals 178; anals 2; subcaudals 12; upper labials 4. Total length of ♂, 345 (325 + 20) mm.

### Uropeltis nitidus (Beddome)

*Silybura nitida* Beddome, 1878, Proc. Zool. Soc. London, p. 154: Anaimalai Hills, India.

♂ ♂, ♀ ♀ (M. C. Z. 47290–3) near Madras (R. H. Beddome) N. D.

Midbody scale-rows 17; ventrals 197–224; anals 2; subcaudals 8–10; upper labials 4. Tail length included in head and body length 21.6–24.1 times in males, 31.2–33.7 times in females. Total length of larger ♂ (M. C. Z. 47292), 328 (315 + 13) mm.; of larger ♀ (M. C. Z. 47293), 278 (270 + 8) mm. This species is discussed further with *U. ocellatus*.

### Uropeltis ocellatus (Beddome)

*Silybura ocellata* Beddome, 1863, Proc. Zool. Soc. London, p. 226: Walaghat, Nilgiri Hills, India.

4 ♂ ♂, ♀ ♀ (M. C. Z. 3857, 3872–3, 3884, 47288–9) near Madras (R. H. Beddome) N. D.

Midbody scale-rows 17; ventrals 186–195; anals 2; subcaudals 8–11; upper labials 4, except on right side of M. C. Z. 3884 where there are 5. Tail length included in head and body length 19.5–21.5 times in males, 25.9–27.2 times in females. Total length of largest ♂ (M. C. Z. 3872), 353.5 (338 + 15.5) mm.; of larger ♀ (M. C. Z. 3857), 254 (245 + 9) mm.

Of the 22 species of *Uropeltis* recognized by Malcolm Smith (1944, pp. 73–74), *ocellatus* is the only one permitted so large a ventral range as 50 (185–234). Those of the others ranging from 8 in the little-known *rubrolineatus* to 35 in *broughami*. This suggests the possibility that *ocellatus*, as now understood, may contain a subspecies.

When Beddome (1863, p. 226) described *ocellatus* from the Nilgiri Hills, it was on the basis of a ♂, ♀, and young specimen. He gave the number of ventrals as 199, this would be the cotype later sexed as ♀ by Boulenger (1893, p. 150).

Later Beddome (1878, p. 154) described *nitidus* from the Anaimalai Hills on the basis of four specimens. He gave the ventrals as 188–194; recounted as 184–195 by Boulenger (1893, p. 152).

The same year Beddome (1878, p. 801) described both *ochracea* and *dupeni* from "Nelliamputty" in the Anaimalai Hills, from seven or more specimens. His combined ventral counts were 214–233, or 214–231 according to Boulenger (1893, pp. 150–151).

Boulenger (1893, p. 150) relegated the last two species to the synonymy of *ocellatus*, but it is interesting to note that his material falls into two groups. Snakes from the Nilgiri and Wynaad Hills having 196–199 ventrals and those from the Anaimalai Hills 214–231. The matter deserves further investigation.

A series of ten specimens labeled *ocellatus* were received at various times from Col. R. H. Beddome by the Museum of Comparative Zoölogy. These snakes were readily separable into two groups according to whether the tail was rounded above (*ocellatus*) or distinctly flattened and somewhat spatulate. One might have supposed this difference to be that of ♂ and ♀ respectively were it not that dissection of every individual shows both sexes to be represented among the snakes of each type of tail, though one of the *ocellatus* females shows a slight approach to the spatulate condition.

This caudal difference was correlated with others which can best be set down in tabular form. Though the snout and eye differences between *ocellatus* and *nitidus* mentioned by Boulenger (*vide infra*) were not discernible, there seems little doubt that the spatulate tailed snakes are *nitidus* and so have been reregistered under that name. Apparently *nitidus* is otherwise still known only from Beddome's types unless, as seems possible, other examples have been called *ocellatus*.

Our material indicates the following differences between the two species in addition to the tail character already discussed:

| Characters, etc. | *ocellatus* | *nitidus* |
|---|---|---|
| Number of specimens | 4 ♂ ♂ 2 ♀ ♀ | 2 ♂ ♂ 2 ♀ ♀ |
| Ventrals in males | 186–189 | 197–206 |
| Ventrals in females | 192–195 | 206–224 |
| Length of rostral | *between* ¼ and ⅓ the length of shielded part of head | ⅓ the length of shielded part of head |
| Length of rostral | equals its distance and ¼ to ⅓ the length of frontal | equals its distance and ½ the length of frontal |
| Length of tail into length of head + body | 19.5–21.5 times in ♂ ♂<br>25.9–27.2 times in ♀ ♀ | 21.6–24.1 times in ♂ ♂<br>31.2–33.7 times in ♀ ♀ |
| Color above variable | but showing much yellow and ocelli very conspicuous | iridescent black, scarcely any yellow, ocelli hardly noticeable |
| Color below | variable but yellow blotches prominent, often predominant | black, uniform or with relatively small yellow blotches or crossbars |

Apart from color, the only differences between the two species that are cited by Boulenger (1893, pp. 150 and 152) are:

| Character | *ocellatus* | *nitidus* |
|---|---|---|
| Snout | pointed | obtusely pointed |
| Rostral | about ¼ the length of the shielded part of head | about ⅓ the length of the shielded part of head |
| Eye | hardly ⅓ length of ocular | not ½ length of ocular |

### Uropeltis wood-masoni (Theobald)

*Silybura wood-masoni* Theobald, 1876, Cat. Rept. Brit. India, p. 135: Palni Hills, India.

4 topotypes (M. C. Z. 18039–42) Shembaganur, Palni Hills (F. Wall) 1923.

Midbody scale-rows 19; ventrals 157–171; anals 2; subcaudals 6–9; upper labials 4. Total length of ♂ (M. C. Z. 18040), 214 (205 + 9) mm., of ♀ (M. C. Z. 18041), 218 (211 + 7) mm.

These counts increase the ventral range from the previous low of 166 of Malcolm Smith.

### Uropeltis macrolepis (Peters)

*Silybura macrolepis* Peters, 1861, Serp. Fam. Uropelt., p. 904: Type locality unknown.

♀ (M. C. Z. 28644) Matheran near Bombay (Brit. Mus.) 1929.

Midbody scale-rows 15; ventrals 130; anals 2; subcaudals 8; upper labials 4. Total length of ♀, 189 (180 + 9) mm.

### Uropeltis ceylanicus Cuvier

*Uropeltis ceylanicus* Cuvier, 1829, Règne Anim., ed. 2, **2**, p. 76: "Ceylon" in error.

5 (M. C. Z. 3852, 3868, 3916) near Madras (R. H. Beddome) N. D.

Midbody scale-rows 17; ventrals 126–146; anals 2; subcaudals 9–10; upper labials 4. Total length of ♂ (M. C. Z. 3868), 249 (234 + 15) mm.

In this series the length of that portion of the rostral visible from above is little more than half the distance from the frontal in the largest and three smallest snakes (M. C. Z. 3852, 3868), but equal to its distance from the frontal in the second largest specimen (M. C. Z. 3916).

### Uropeltis arcticeps (Günther)

*Silybura arcticeps* Günther, 1875, Proc. Zool. Soc. London, p. 229, fig. 1: Tinnevelly Hills, India.

♀ (M. C. Z. 22389) Travancore Hills (Brit. Mus.) 1926.

Midbody scale-rows 17; ventrals 148; anals 2; subcaudals 9; upper labials 4. Total length of ♀, 287 (271 + 16) mm.

### Uropeltis rubromaculatus (Beddome)

*Silybura rubromaculata* Beddome, 1867, Madras Quart. Journ. Med. Sci., **11**, p. 15, pl. ii, fig. 3: Anaimalai Hills, India.

♀ topotype (M. C. Z. 6199) Anaimalai Hills (Brit. Mus.) 1888.

Midbody scale-rows 17; ventrals 127; anals 2; subcaudals 9; upper labials 4. Total length of ♀, 287 (272 + 15) mm.

### Uropeltis rubrolineatus (Günther)

*Silybura rubrolineata* Günther, 1875, Proc. Zool. Soc. London, p. 228: Travancore Hills, India.

*Silybura phipsonii* Mason, 1888, Ann. Mag. Nat. Hist. (6), **1**, p. 184: Bombay Ghats, India.

12 (M. C. Z. 3850, 3880–1, 3911, 47034–40, 47101) Madras (R. H. Beddome) N. D.

♂ (M. C. Z. 22381) India (Brit. Mus.) 1926.

3 (A. M. N. H. 46307–9) Panchgani, Satara District (C. McCann) 1930.

Midbody scale-rows 17; ventrals 136–167; anals 2; subcaudals 7–12; upper labials 4. Tail length included in head and body length apparently 15–21 times in males, 22–25 times in females. Total length of largest ♂ (M. C. Z. 22381), 267 (255 + 12) mm.; of largest ♀ (M. C. Z. 3850), 229 (220 + 9) mm.

In his key to the genus *Uropeltis*, Malcolm Smith (1943, pp. 74, 82) separates *rubrolineatus* and *phipsonii* as follows:

Portion of rostral visible from above not or not much longer than its distance from the frontal; a broad yellow (red) stripe along each side of the body; ventrals 165–172; range: Western Ghats south of the Palghat Gap, Anaimalai and Travancore Hills..... *rubrolineatus*
Portion of rostral visible from above distinctly longer than its distance from the frontal; a yellow streak along each side of the body in front; ventrals 138–157; range: Western Ghats from the Bombay Hills to the Anaimalai Hills..... *phipsonii*

The question arose as to whether we are dealing with a northern race with less numerous ventrals and a southern race with more. Unfortunately this could not be settled by reference to M. C. Z. material as it was so poorly localized. However, the American Museum placed at my disposal a small series from Panchgani in the extreme northern part of the joint ranges. From the locality it might be expected that these Panchgani snakes would be referable to *phipsonii*, with which they certainly agree in coloration and number of ventrals (137–140). On the other hand in all three snakes the visible portion of the rostral is equal to its distance from the frontal and in one (A. M. N. H. 46308) the yellow lateral stripe is more or less continuous from head to anus.

This lateral stripe is present anteriorly on almost every snake in the Madras series, though almost indistinguishable in a few specimens. Yellow spots, especially prominent in one Panchgani reptile (A.M.N.H. 46309), are to be found on a few Madras snakes even if inconspicuous. There is considerable variation in the U-shaped marking on the subcaudals, but it is shown by all sixteen snakes.

The portion of rostral visible from above is equal to (7 examples), or longer than (5 examples), its distance from the frontal, in the Madras series whose ventrals range from 136–167. In view of the combined ventral range of *rubrolineatus* and *phipsonii* (136–172) being within that permitted for certain other members of the genus, it seems reasonable to assume that only one species is represented. Possibly with more material an average difference in scale counts may be demonstrated.

In so far as its rostral length is only a quarter that of the shielded portion of the head, M. C. Z. 3880 agrees with *rubrolineatus*, but M. C. Z. 3881, where it is between a quarter and a third, is an intermediate.

The eye diameter is less than half the length of the ocular shield i. e. *rubrolineatus*, in all but M. C. Z. 3880 and 47034.

In the Madras series, which, incidentally, were received as "*beddomei* Günther," the truncated portion of the tail is certainly large, and in most cases "flat," though some appear to be very slightly convex.

When M. C. Z. 22381, received as *phipsonii* from the British Museum in 1926 (apparently one of the specimens listed by Boulenger 1893, p. 155), was examined, it was found to agree with *rubrolineatus* in rostral length, but with *phipsonii* in the eye character and number of ventrals.

It would seem probable, therefore, that *phipsonii* is either a synonym of *rubrolineatus* or at most a northern race, for no constant structural characters have been found to separate them, and the U-shaped mark on the subcaudal region is present on the entire M. C. Z. series. Only in its paler brown hue (? faded) and larger size does the British Museum snake differ in coloration from the average darker colored Madras series.

### Uropeltis petersi (Beddome)

*Silybura petersi* Beddome, 1878, Proc. Zool. Soc. London, p. 154: Anaimalai Hills, India.

4 topotypes (M. C. Z. 6201) Anaimalai Hills at 4,700 feet (Brit. Mus.) 1888.

Midbody scale-rows 17; ventrals 150–156; anals 2; subcaudals 6–10; upper labials 4. Total length of ♂, 185 (173 + 12) mm.

### Uropeltis pulneyensis (Beddome)

*Plectrurus pulneyensis* Beddome, 1863, Proc. Zool. Soc. London, p. 228, pl. xxv, fig. 2: Palni Hills, India.

♀ (M. C. Z. 1335) Periyakulam, Madura District (D. C. Scudder) 1863.

4 topotypes (M. C. Z. 7773, 33506–7) Kodaikanal, Palni Hills (T. Kolbe) 1859.

4 (M. C. Z. 3870, 47041–3) near Madras (R. H. Beddome) N. D.

Midbody scale-rows 17; ventrals 156–180; anals 2; subcaudals 7–12; upper labials 4. Total length of ♀ (M. C. Z. 1335), 354 (342 + 12) mm.

Ventral counts of 156 and 159 bring Roux's (1928, p. 441) count of 154 within the range of probability.

### Uropeltis grandis (Beddome)

*Rhinophis grandis* Beddome, 1867, Madras Quart. Journ. Med. Sci., **11**, p. 15, pl. ii, fig. 4: Anaimalai Hills, India.

3 topotypes (M. C. Z. 6200) Anaimalai Hills (Brit. Mus.) 1888.

Midbody scale-rows 19; ventrals 190–201; anals 2; subcaudals 6–12; upper labials 4. Total length of ♂, 388 (370 + 18) mm.

### Rhinophis sanguineus Beddome

*Rhinophis sanguineus* Beddome, 1863, Proc. Zool. Soc. London, p. 227: Cherambody, Malabar, India.

3 (M. C. Z. 3854A, 3854B, 3865) near Madras (R. H. Beddome) N. D.

Midbody scale-rows 15; ventrals 188–194; anals 2; subcaudals 6–9; upper labials 4. Total length of ♂ (M. C. Z. 3865), 252 (245 + 7) mm., of larger ♀ (M. C. Z. 3854A), 458 (445 + 13) mm.

## XENOPELTIDAE

### Xenopeltis unicolor Reinwardt

*Xenopeltis unicolor* Reinwardt, in Boie, 1827, Isis von Oken, p. 564: Java.

♂ (M. C. Z. 3114) Calcutta (W. Theobald) 1866.

Midbody scale-rows 15; ventrals 183; anal 1 (?); subcaudals 26; upper labials 8 (4, 5); loreal 0; preocular 1; postoculars 2; temporals 2 + 3. Total length of ♂, 895 (810 + 85) mm.

Apparently this species has not been recorded from India before, therefore this old record should be accepted with reserve.

## BOIDAE

### Python molurus molurus (Linnaeus)

*Coluber molurus* Linnaeus, 1758, Syst. Nat. ed. 10, **1**, p. 225: India.

2 eggs (Exhibition) India (Percy Watson) N. D.
Skeleton (M. C. Z. 4246) India (E. Gerrard) 1877.
Skull (M. C. Z. 4278) India (E. Gerrard) 1877.
♂ alc. (M. C. Z. 31475) Agra ("Snake King") 1931.

There are also three mounted specimens with inadequate data indirectly received from zoological gardens and a circus.

Midbody scale-rows 68–70; ventrals 253; anal 1; subcaudals 65; upper labials 12–13, the 6th (left) or 7th (right) just entering the orbit; preoculars 2; postoculars 3; lance-shaped mark on crown indistinct anteriorly. Total length (M. C. Z. 31475), 1965 (1720 + 245) mm.

Deraniyagala (1945, Spolia Zeylanica, **24**, pp. 103–105) has split *P. molurus* as recognized by M. A. Smith into three races. *P. m. orbiculata* is separated from *P. m. molurus* and *P. m. pimbura* by means of the shape of the dark lateral markings, but in M. C. Z. 31475 from Agra and a non-localized mounted example (M. C. Z. 46622) there is much variation in the nearly median lateral markings, which approximates to that illustrated by Deraniyagala for the alleged races. Deraniyagala then separates *pimbura* from *molurus* on the basis of subcaudal counts, for both midbody scale rows (63–69 and 62–72) and ventrals (248–257 and 244–254), as given by him, overlap for most of their range. In the case of the subcaudals (57–65 for *pimbura*, 66–67 for *molurus*), the data, particularly for *molurus* based on only three examples, appears inadequate for the separation of races whose alleged differences in color pattern our series seems to indicate are of little value.

### Eryx conicus (Schneider)

*Boa conica* Schneider, 1801, Hist. Amphib., **2**, p. 268: So. India.

3 ♂ ♂ (M. C. Z. 3885) Madras, (R. H. Beddome) N. D.
♀ ♀ (M. C. Z. 4181, 18380) India (A. Agassiz & T. Barbour) 1877 & 1924.

There is also an unlocalized mounted example from the New York Zoological Society.

Midbody scale-rows 44–50; ventrals 168–185; anal 1; subcaudals 16–21; upper labials 12–15; mental groove absent; tail pointed. Total length of ♀ (M. C. Z. 18380), 680 (640 + 40) mm.

### Eryx johnii johnii (Russell)

*Boa johnii* Russell, 1801, Ind. Serp., **2**, pp. 18, 20, pls. xvi-xvii: Tranquebar, India.

♀, ♂ (M. C. Z. 4211, 6675) India (A. Agassiz & T. Barbour) 1877 & 1903.

Midbody scale-rows 58–61; ventrals 200–201; anal 1; subcaudals 33–34; upper labials 10–11; mental groove present; tail blunt. Total length of ♂ (M. C. Z. 6675), 755 (670 + 85) mm.

Dr. O. G. Stull, who made an intensive study of the Boidae in American collections some years ago, informs me that she recognizes the northwestern race *persicus* Nikolski on the basis of the following characters:

Midbody scale-rows 47–56; ventrals 187–206; subcaudals 26–37; ventrals + caudals total 212–239 ..... *j. persicus*

Midbody scale-rows 57–65; ventrals 194–215; subcaudals 27–40; ventrals + caudals total 226–245 ..... *j. johnii*

### Eryx johnii persicus Nikolski

*Eryx persicus* Nikolski, 1907 (1905), Ann. Mus. Zool. St. Petersburg, **10**, p. 290, fig. 8: Aguliashker, Arabistan region, S. W. Persia.

♀ (M. C. Z. 3764) within 100 miles of Ambala (M. M. Carleton) N. D.

Midbody scale-rows 53; ventrals 187; anal 1; subcaudals 33; upper labials 10. Total length of ♀, 518 (460 + 58) mm.

Undoubtedly referable to *j. persicus* on the characters given by Dr. Stull, this snake from the extreme eastern Punjab extends the range considerably, for Malcolm Smith (1943, p. 114) includes the Punjab in the range of *j. johnii* and states that the typical form meets with *j. persicus* in Baluchistan and the Northwest Frontier Province.

## COLUBRIDAE

### Elaphe helena (Daudin)

*Coluber helena* Daudin, 1803, Hist. Nat. Rept., **6**, p. 277: Vizagapatam, India.

♂, ♀ ♀ (M. C. Z. 3895) Madras (R. H. Beddome) N. D.

Midbody scale-rows 25; ventrals 231–254; anal 1; subcaudals 84–99; upper labials 9 (5, 6); loreal 1; preocular 1; postoculars 2; except on left side of one snake where only 1 is present; temporals usually 2 + 2, also 2 + 3, 2 + 4, and 1 + 2. Total length of ♂, 397 (315 + 82) mm.

Two of these southeast Indian specimens show the white, black-edged, nuchal collar interrupted on the median line. This pattern M. A. Smith (1943, p. 150) considers restricted to the Western Ghats of Southern India. The color pattern of the remaining specimen is intermediate between this and the normal one, having two posteriorly converging or parallel black stripes on the neck.

### Elaphe hodgsonii (Günther)

*Spilotes hodgsonii* Günther, 1860, Proc. Zool. Soc. London, p. 156, pl. xxvii: Nepal, India.

♂ ♂ (M. C. Z. 3134, 3146) Kulu Valley (M. M. Carleton) 1874.
3 ♂ ♂, ♀ (M. C. Z. 4488) near Ambala (M. M. Carleton) 1878.

Midbody scale-rows 23; ventrals 237–246; anals 2; subcaudals 87–91; upper labials 8 (4, 5); loreal 1; preocular 1; postocular 2; temporals 2 + 3 on at least one side, with 2 + 2, 2 + 4, 3 + 3, or 3 + 4 on the other. Total length of ♂ (M. C. Z. 3146), 1430 (1120 + 310) mm.

The feeble keeling of the scales in the ischiadic region, used in M. A. Smith's (1943, p. 142) key to the genus, is very faint indeed in the adult snake, and not to be found in the others since all are young.

### Elaphe cantoris (Boulenger)

*Coluber cantoris* Boulenger, 1894, Cat. Snakes Brit. Mus., **2**, p. 35: Himalayas. India; Khasi and Garo Hills, Assam, India; Burma.

Cotype ♀ (M. C. Z. 28646) Khasi Hills (Brit. Mus.) 1929.

Midbody scale-rows 17; ventrals 233; anals 2; subcaudals 69+; upper labials 8 (4, 5); loreal 1; preocular 1; postoculars 2; temporals 2 + 3. Total length of ♀, 959 (790 + 169) mm.

Here again the keeling is absent on the outer rows of ventrals and very faint on the remainder. This specimen is interesting in having a divided, instead of the usual single, anal.

### Ptyas mucosus (Linnaeus)

*Coluber mucosus* Linnaeus, 1758, Syst. Nat. ed. 10, **1**, p. 226, and 1754, Mus. Ad. Frid., **1**, p. 37, pl. xxiii: India.

♂ (M. C. Z. 1329) Periyakulam, Madura District (D. C. Scudder) 1866.
♂ ♂ (M. C. Z. 2193) Ganges (Paris Mus.) 1865.
♂ (M. C. Z. 3109) Calcutta (W. Theobald) 1866.
♂ (M. C. Z. 3853) Madras (R. H. Beddome) 1876.
♂ (M. C. Z. 4024) Kulu Valley (M. M. Carleton) 1877.
♀ (M. C. Z. 19572) Calcutta (T. Barbour) 1904.

Midbody scale-rows 17; ventrals 190–199; anals 2; subcaudals 109–133; upper labials 8 (4, 5); loreals 2–4, 4 only on right side of M. C. Z. 2193; preocular 1; postoculars 2; temporals 2 + 2 or 2 + 3. Total length of ♂ (M. C. Z. 2193), 2290 (1700 + 590) mm.

M. C. Z. 3109, received as *Ptyas blumenbachii* (Merrem), differs in having prominent dark keels on the more dorsally placed scales on the posterior part of the body, also in the absence of the characteristic dark cross-bars.

### Coluber ventromaculatus Gray & Hardwicke

*Coluber ventromaculatus* Gray & Hardwicke, 1834, Illus. Indian Zool., **2**, pl. lxxx, fig. 1: Type locality unknown.

juv. (M. C. Z. 15819) Karachi, Sind (F. Wall) 1921.

Midbody scale-rows 19; ventrals 210; anals 2; subcaudals 104; upper labials 8 (5, 6); loreals 2; preoculars 2; postoculars 2; temporals 2 + 2 (not 2 + 3 as in M. A. Smith, 1943, p. 168). Total length of juvenile, 308 (232 + 76) mm.

### Coluber fasciolatus Shaw

*Coluber fasciolatus* Shaw, 1802, Gen. Zool., **3**, p. 528: India.

♂ (M. C. Z. 28645) Bangalore (Brit. Mus.) 1929.

Midbody scale-rows 21; ventrals 192; anals 2; subcaudals 82; upper labials 7 (4, 5); loreal 1; preocular 1; postoculars 2; temporals 2 + 3. Total length of ♂, 341 (270 + 71) mm. This specimen is unusual in having seven instead of the normal 8 upper labials.

### Coluber diadema Schlegel

*Coluber diadema* Schlegel, 1837, Phys. Serp., **2**, p. 148: near Bombay, India.

♂ ♂ (M. C. Z. 3766, 9913) Ambala (M. M. Carleton) 1874.

Midbody scale-rows 29; ventrals 243–247; anal 1; subcaudals 102–107; upper labials 10–11, none entering orbit; loreals 2; preoculars 2; postoculars 2–3; temporals 4 + 3, 4 + 4, or 4 +5. Total length of smaller ♂ (M. C. Z. 3766), 758 (600 + 158) mm. The larger is skinned out.

The single anal is normal and "2" given by M. A. Smith (1943, p. 173) is evidently a misprint. Smith lists two "color forms" saying that the range of *C. d. atriceps* (Fischer) is much the same as that of *C. d. diadema* but less extensive. The pattern of the smaller male listed above corresponds to that of the typical form, that of the larger to *atriceps*. Under the circumstances it seems best to treat this snake binomially, at least pending the comprehensive revision forecast by Schmidt (1939, p. 77) who tentatively divides "*diadema*" into three or four *species!*

### Opheodrys calamaria (Günther)

*Cyclophis calamaria* Günther, 1858, Cat. Snakes Brit. Mus., p. 250: Ceylon.

♂, ♀ ♀ (M. C. Z. 3844, 3908) near Madras (R. H. Beddome) N. D.

Midbody scale-rows 15; ventrals 133–146; anals 2; subcaudals 60–71; upper labials 7 (3, 4); loreal 0; preocular 1; postoculars 2; temporals 1 + 2. Total length of ♀ (M. C. Z. 3844), 303 (222 + 81) mm.

In as far as colour seems to be the only constant basis for separating *Liopeltis* from *Ophcodrys* (M. A. Smith, 1943, pp. 136, 177 and 182), I follow most American herpetologists in regarding *Liopeltis* as a synonym.

### Opheodrys rappii (Günther)

*Ablabes rappii* Günther, 1860, Proc. Zool. Soc. London, p. 154, pl. xxvi, fig. B: Sikkim, India.

♂, ♀ (M. C. Z. 3137, 3147) Kulu Valley (M. M. Carleton) N. D.
♂ (M. C. Z. 4489) Ambala (M. M. Carleton) 1880.

Midbody scale-rows 15; ventrals 191–192; anals 2; subcaudals 61–65; upper labials 6 (3, 4) or 5 (3, 4) on right side of M. C. Z. 3147

only; loreal 1; preocular 1; postoculars 2; temporals 1 + 1. Total length of ♂ (M. C. Z. 3147), 533 (422 + 111) mm.

### Oligodon cyclurus (Cantor)

*Coronella cyclura* Cantor, 1839, Proc. Zool. Soc. London, p. 50: Type locality unknown.

juv. (M. C. Z. 2281) North India (M. M. Carleton) 1873.

Midbody scale rows 19; ventrals 168; anal 1; subcaudals 47; upper labials 8 (4, 5); loreal 1; preocular 1; subocular 1; postoculars 2; temporals 2 + 2. Coloration is that of form I of M. A. Smith (1943, pp. 202–204) except that the head markings are very well defined. Total length of juv., 177 (150 + 27) mm.

### Oligodon albocinctus (Cantor)

*Coronella albocincta* Cantor, 1839, Proc. Zool. Soc. London, p. 50: Cherrapunji, Assam, India.

♂ (M. C. Z. 22378) Himalayas (Brit. Mus.) 1926.

Midbody scale-rows 21; ventrals 183; anal 1; subcaudals 62; upper labials 7 (3, 4); loreal 1; preocular 1; postoculars 2; temporals 1 + 2. Coloration is that of form II of M. A. Smith (1943, p. 212). Total length of ♂, 730 (580 + 150) mm.

### Oligodon theobaldi (Günther)

*Simotes theobaldi* Günther, 1868, Ann. Mag. Nat. Hist. (4), **1**, p. 417: Pegu, Burma.

♂ (M. C. Z. 3910) Madras (R. H. Beddome) 1876.

Midbody scale rows 17; ventrals 177; anals 2; subcaudals 47; upper labials 7 (3, 4); loreal 1; preoculars 1; postoculars 2; temporals 1 + 2. Total length of ♂, 371 (312 + 59) mm.

Malcolm Smith (1943, p. 220) includes *Simotes beddomii* Boulenger, whose type locality was the Wynaad District near Madras, under his synonymy of *O. theobaldi* but gives the range of *theobaldi* as Assam and Burma. M. C. Z. 3910, originally received as *beddomii*, is almost certainly from South India and appears indistinguishable from specimens of *theobaldi* from Burma, the only difference being that it shows

an undivided nasal while in Burmese examples the nasal is divided. This character was used by Boulenger (1890, pp. 310, 314–5) to distinguish the alleged species. If it fails to separate them subspecifically, it seems necessary to extend the range of *theobaldi* to include the hills of South India.

### Oligodon cruentatus (Günther)

*Simotes cruentatus* Günther, 1868, Ann. Mag. Nat. Hist. (4), **1**, p. 417: Pegu, Burma.

♀, juv. (M. C. Z. 2279) North India (M. M. Carleton) 1873.

Midbody scale rows 17; ventrals 163–170; anals 2; subcaudals 30–37; upper labials 8 (4, 5); loreal 1; preocular 1; postoculars 2; temporals 1 + 2. Total length of ♀, 386 (340 + 46) mm.

Most of the Rev. M. M. Carleton's collections came from the Punjab but these specimens were not further localized than North India. Malcolm Smith (1943, p. 221) gives Burma between lats. 16° and 20° N. as the range of this species. Careful examination, and comparison with Burmese specimens of *cruentatus*, show that these snakes agree perfectly with Dr. Smith's description of the species except for slight color differences. Both show the characteristic annuli on the base and tip of the tail, both lack the dark brown longitudinal stripes sometimes seen in this species, but the adult shows the faint dark reticulations on the back anteriorly coalescing to form four, fine, longitudinal lines of which the outer pair are most distinct; the juvenile shows four similar longitudinal rows of minute ocelli, each covering about half a scale.

### Oligodon taeniolatus (Jerdon)

*Coronella taeniolata* Jerdon, 1853, Journ. Asiatic Soc. Bengal, **22**, p. 528: Vizagapatam, India.

♀, ♂ (M. C. Z. 3842, 3869) Malabar (R. H. Beddome) N. D.
♂ (M. C. Z. 3848) near Madras (R. H. Beddome) N. D.
♂, juv. (M. C. Z. 3904) Southern India (R. H. Beddome) N. D.
♂ (M. C. Z. 18061) Taliparamba, Madras (F. Wall) 1923.

Midbody scale-rows 13–15 (13 in M. C. Z. 3842 only); ventrals 166–172; anals 2; subcaudals 37–49; upper labials 7 (3, 4); loreal 1; preocular 1; postoculars 2; temporals 1 + 2 or 1 + 4 (on right side

of M. C. Z. 3842 only). Total length of ♂ (M. C. Z. 3848), 455 (385 + 70) mm.

Apparently M. C. Z. 3842 is the first recorded example of *taeniolatus* with 13 midbody scale-rows. Mr. Loveridge, who examined the snake at my request, agrees that it is conspecific with the others. In coloration M. C. Z. 3842 and 3904 (♂) agree with form I of M. A. Smith (1943, p. 224); M. C. Z. 3869, 3848 and 3904 (juv.) are form II, while M. C. Z. 18061 corresponds to form IV.

### Oligodon arnensis (Shaw)

*Coluber arnensis* Shaw, 1802, Gen. Zool., **3**, p. 526: Vizagapatam and Arni, India.

juv. (M. C. Z. 4065) Kulu Valley (M. M. Carleton) 1876.
♀ (M. C. Z. 4491) Ambala (M. M. Carleton) 1880.

Midbody scale rows 17; ventrals 187–190; anals 2; subcaudals 39–52; upper labials 7 (3, 4) with the 6th excluded from the border of the lip in M. C. Z. 4491, or 6 (2, 3) with the 5th excluded from the lip on one side in M. C. Z. 4065; loreal 1; preocular 1; a tiny subocular present on one side in M. C. Z. 4065; postoculars 2; temporals 1 + 2. The ventrals are not angulate laterally in the larger snake and only slightly so in the juvenile. Total length of ♀, 502 (420 + 82) mm.

F. Wall (1923, p. 324), in discussing this species, gives a range of 28–40 dark, white-edged, dorsal bars on the body with 7–20 on the tail for specimens from north of the Ganges, and records one snake with 47 bars on the body from Bihar. Malcolm Smith (1943, p. 227) remarks that his conclusions differ from those of Wall as regards the geographical distribution of the number of bars and gives a range of 7–20 on the body and 7–20 on the tail for examples from India north of lat. 20°. The maximum number of bars he mentions for any part of the range of this species is 30 on the body and 16 on the tail. Our two well-localized snakes would seem to support Wall's conclusions. The adult has 44 bars on the body and 13 on the tail, while the juvenile exhibits 45 bars on the body and 11 on the tail.

### Oligodon affinis Günther

*Oligodon affinis* Günther, 1862, Ann. Mag. Nat. Hist. (3), **9**, p. 58: Anaimalai Hills, India.

♂ (M. C. Z. 3839) Madras Presidency (R. H. Beddome) N. D.

Midbody scale-rows 17; ventrals 144; anals 2; subcaudals 27; upper labials 7 (3, 4); loreal 0; preoculars 2; postoculars 2; temporals 1 + 1. Total length of ♂, 311 (270 + 41) mm.

This snake is unusual in showing two preoculars; one being considered constant for the genus by M. Smith (1943, p. 196).

### Ahaetulla ahaetulla ahaetulla (Linnaeus)

*Coluber ahaetulla* Linnaeus, 1758, Syst. Nat. ed. 10, **1**, p. 225 (part): Asia (restricted).

♂ (M. C. Z. 3194) Calcutta (W. Theobald) 1866.
3 ♂ ♂ (M. C. Z. 3840, 3862, 3893) Madras (R. H. Beddome) N. D.
♂ (M. C. Z. 4204) India (E. Gerrard) 1877.

Midbody scale-rows 15; ventrals 163–188; anals 2; subcaudals 138–153; upper labials 9 (4, 5, 6) or 8 (4, 5) in M. C. Z. 3893 only, or 9 (5, 6) in M. C. Z. 3862 only; loreal 1; preocular 1; postoculars 2; temporals 2 + 2, rarely 1 + 2 (M. C. Z. 3194) or 2 + 1 (M. C. Z. 3862). Total length of ♂ (M. C. Z. 3194), 905 (600 + 305) mm.

In coloration M. C. Z. 4204 agrees with form I of M. A. Smith (1943, p. 243) while all the others are of form II, which is allegedly confined to Southern India. It is quite possible that the Calcutta specimen may have come from further south.

### Ahaetulla grandoculis (Boulenger)

*Dendrophis grandoculis* Boulenger, 1890, Fauna Brit. India, Rept. Batr., p. 337: Tinnevelly Hills and Coonoor Ghat, India.

♂ (M. C. Z. 3863) Madras (R. H. Beddome) N. D.

Midbody scale rows 15; ventrals 180; anals 2; subcaudals 133; upper labials 9 (4, 5, 6); loreal 1; preocular 1; postoculars 2; temporals 1 + 2 and 2 + 2. Total length of ♂, 1035 (710 + 325) mm.

This snake considerably increases the limited subcaudal range of 117–124 given by M. A. Smith (1943, p. 246), and has apparently only 30, instead of 31–33, maxillary teeth (*loc. cit.*, p. 245).

### Chrysopelea ornata (Shaw)

*Coluber ornatus* Shaw, 1802, Gen. Zool., **3**, p. 477: East India Islands.

♀ ♀ (M. C. Z. 3113, 3115) Calcutta (W. Theobald) 1866.
♂ (M. C. Z. 3903) Madras (R. H. Beddome) N. D.

Midbody scale-rows 17; ventrals 215–222; anals 2; subcaudals 117–120; upper labials 9 (4, 5, 6); loreal 1; preocular 1; postoculars 2; temporals 2 + 2. Total length of ♀ (M. C. Z. 3115), 963 (710 + 253) mm.

In coloration M. C. Z. 3113 agrees with form I of M. A. Smith (1943, p. 252); M. C. Z. 3115 is intermediate between forms I and II, and M. C. Z. 3903 is immature.

Deraniyagala (1945, Spolia Zeylanica, **24**, p. 106) has recently described a Ceylonese race of *Chrysopelea ornata* as *lankavae*. In so far as the description of this form is apparently based entirely upon the nature of the dorsal spots, our series, though small, casts some doubt on its validity.

In a young 396 mm. snake (M. C. Z. 39811) from Udakelle Estate, Polganivella, Ceylon, the rosette-like markings are very distinct, covering 4, 5, or even, though rarely, 6 scales, thus conforming to *lankavae*. However, it differs from this form in having the spots upon every, instead of only the alternate, crossbar.

Even more distinct than in this Ceylonese example are the vertebral spots, covering 4 to 6 scales, in a Madras snake (M. C. Z. 3903); but in this specimen, particularly posteriorly, there are indications of a very fine crossbar between each of the larger ones showing a vertebral spot, so that this Indian specimen, too, appears to conform to *lankavae*.

Apparently M. C. Z. 3113 from Calcutta might be placed in either race for it shows distinct vertebral spots of 4 to 5 scales in size on alternate crossbars.

### Chrysopelea taprobanica Smith

*Chrysopelea taprobanica* Smith, 1943, Fauna Brit. India, Rept. Amphib., **3**, p. 254: Kanthali, Ceylon.

♂, head (M. C. Z. 47881) near Madras (R. H. Beddome) N. D.

Midbody scale-rows 17; ventrals 208; anals 2; subcaudals 120; upper labials 9 (4, 5, 6); loreal 1; preocular 1; postoculars 2; temporals 2 + 2. Total length of ♂, 785 (560 + 225) mm.

These examples show that this species, originally described as from Ceylon alone, also occurs on the Indian mainland.

### Lycodon subcinctus Boie

*Lycodon subcinctus* Boie, 1827, Isis von Oken, p. 551: Java.

♂ (M. C. Z. 2236) Pondichéry (Paris Mus.) 1865.

Midbody scale-rows 17; ventrals 206; anals 2; subcaudals 76; upper labials 8 (3, 4, 5); loreal 1; preocular 0; postoculars 2; temporals 1 + 2. Total length of ♂, 310 (255 + 55) mm.

Peninsular India is well outside the range of this snake according to M. A. Smith (1943, p. 258), but it is quite likely that this locality is erroneous. The specimen was received in exchange from A. A. Duméril.

### Lycodon striatus (Shaw)

*Coluber striatus* Shaw, 1802, Gen. Zool., **3**, p. 527: Vizagapatam and Hyderabad, India.

♂ ♂, ♀ (M. C. Z. 3144) Kulu Valley (M. M. Carleton) 1874.
♂ (M. C. Z. 4784) Madras (R. H. Beddome) N. D.

Midbody scale-rows 17; ventrals 161–180; anals 2; subcaudals 49–58; upper labials 8 (3, 4, 5) or 6 (3, 4) in M. C. Z. 3144 (♀) only; loreal 1; preocular 1; postoculars 2; temporals 1 + 2, 2 + 2, or 2 + 3, the arrangement being often azygous. Total lengths of ♂ ♂ (M. C. Z. 3144A, 3144B), 333 (270 + 63) mm.

### Lycodon aulicus aulicus (Linnaeus)

*Coluber aulicus* Linnaeus, 1758, Syst. Nat. ed. 10, **1**, p. 220, and 1754, Mus. Ad. Frid., **1**, p. 29, pl. xii, fig. 2: "America."

♂, ♀ ♀ (M. C. Z. 4269, 3212, 5400) Ambala (M. M. Carleton) 1877 & 1879.
♂ ♂, ♀ ♀ (M. C. Z. 3877, 3912, 4783) Madras (R. H. Beddome) N. D.
♂ (M. C. Z. 4846) Bombay (no further data).
♀ (M. C. Z. 7541) Lucknow (T. Barbour) 1907.

Midbody scale-rows 17; ventrals 182–214; anals 2, except in M. C. Z. 3877 and 4783 (♂) where it is single; subcaudals 57–72; upper labials 9 (3, 4, 5); loreal 1; preocular 1; postoculars 2; temporals usually 2 + 3, rarely 1 + 2, 1 + 3, or 2 + 4. Total length of ♀ (M. C. Z. 7541), 675 (565 + 110) mm.

My reasons for employing trinomials are explained below.

### Lycodon aulicus travancoricus (Beddome)

*Cercaspis travancoricus* Beddome, 1870, Madras Month. Journ. Med. Sci., **2**, p. 169: Travancore Hills, India.

♂ (M. C. Z. 2232) Pondichéry (Paris Mus.) 1865.
♀ ♀ (M. C. Z. 3856, 47887) Madras (R. H. Beddome) N. D.
♂, ♀ (M. C. Z. 6206) Anaimalai Hills (Brit. Mus.) 1888.
♀ (M. C. Z. 18050) Taliparamba, Madras (F. Wall) 1923.

Midbody scale-rows 17; ventrals 183–205; anal 1; subcaudals 62–70; upper labials 9 (3, 4, 5) or 8 (2, 3, 4) in M. C. Z. 47887 only; loreal 1; preocular 1; postoculars 2; temporals 2 + 3 except M. C. Z. 2232 which has 1 + 3 (R) and 2 + 4 (L). Total length of ♀ (M. C. Z. 2232), 508 (410 + 98) mm.

In Malcolm A. Smith (1943, pp. 259, 263–265) *L. aulicus* and *L. travancoricus* are regarded as full species separated by the divided anal of *aulicus*, single in *travancoricus*; and the loreal separated from, or only just touching, the internasal in *travancoricus*, while it is extensively in contact in *aulicus*.

On the basis of these characters our specimens include three intermediates between these two forms, which would suggest that their relationship is rather that of subspecies than specific. These intermediates are:

♂ (M. C. Z. 2232) which has a single anal and the loreal well in contact with the internasals and is seemingly closest to *travancoricus*.

♂ ♂ (M. C. Z. 3877, 4783) each with a single anal and the loreal extensively in contact with the internasal and apparently closer to *aulicus*.

In coloration there seems to be a tendency for the cross-bars of *travancoricus*, particularly in the young where those on the tail are still distinguishable, to be more numerous (27–51) than in *aulicus* (12–50, with most 16–25 and only one as high as 50).

There are also slight differences in the hemipenes according to Dr. Smith, but being without a mature male of *travancoricus* I was unable to evaluate these.

It will be observed that we have both races (including intermediates) from near Madras, which area is included in the range of both "species" as outlined by Dr. Smith. Undoubtedly the ranges of *aulicus* and *travancoricus* overlap.

M. C. Z. 2232 formed part of an exchange from A. A. Duméril. M. C. Z. 6206 (♂, ♀) were received from the British Museum as *Lycodon striatus* (Shaw).

### Dryocalamus gracilis (Günther)

*Odontomus gracilis* Günther, 1864, Rept. Brit. India, p. 234: Anaimalai Hills, India.

♂ (M. C. Z. 4105) Madras (R. H. Beddome) N. D.

Midbody scale-rows 15; ventrals 237; anal 1; subcaudals 83+; upper labials 7 (3, 4); loreal 1; preocular 1 (L) or 2 (R), apparently a reversion to the more primitive condition in which the loreal is separated from the eye by a preocular; postocular 1; temporals 2 + 3. Total length of ♂, 274+ (220 + 54+) mm.

### sibynophis collaris (Gray)

*Psammophis collaris* Gray, 1853, Ann. Mag. Nat. Hist. (2), **12**, p. 390: Khasi Hills, India.

♀ ♀, ♂ (M. C. Z. 3136, 3141, 3148) Kulu Valley (M. M. Carleton) 1874.

Midbody scale-rows 17; ventrals 173–176; anals 2; subcaudals 72+ — 85+; upper labials 10 (4, 5, 6); loreal 1; preoculars 1; postoculars 2; temporals 1 + 2. Total length of ♀ (M. C. Z. 3136), 583+ (428 + 155+) mm.

### Sibynophis subpunctatus (Duméril & Bibron)

*Oligodon subpunctatus* Duméril & Bibron, 1854, Erpét. Gén., **7**, p. 58: Malabar, India.

♂ (M. C. Z. 3897) near Madras (R. H. Beddome) N. D.
♂ (M. C. Z. 5395) Calcutta (No further data).
♀ ♀, ♂ (M. C. Z. 18047–9) Taliparamba, Madras (F. Wall) 1923.

Midbody scale-rows 17; ventrals 161–170; anals 2; subcaudals 57–64; upper labials 9 (4, 5, 6); loreal 1; preocular 1; postoculars 2; temporals 2 + 2. Total length of ♂ (M. C. Z. 3897), 382 (286 + 96) mm.

### Natrix piscator (Schneider)

*Hydrus piscator* Schneider, 1799, Hist. Amphib., **1**, p. 247: East Indies.

♀, ♂ (M. C. Z. 3112, 3193) Calcutta (W. Theobald) 1866.
♂ ♂ (M. C. Z. 3855, 3887) near Madras (R. H. Beddome) N. D.
♀, ♂ (M. C. Z. 7540, 15716) Lucknow (T. Barbour) 1907.

Midbody scale-rows 19; ventrals 136–146; anals 2; subcaudals 62–88; upper labials 9 (4, 5) except in M. C. Z. 7540 which has 9 (4) on the right and 10 (5) on the left; loreal 1; preoculars 1–2 (2 on right of M. C. Z. 3112 only); postoculars 3–4 (4 on left of M. C. Z. 3112 only, while M. C. Z. 15716 has 4 post + suboculars on each side); temporals 2 + 2 and 2 + 3. Total length of ♀ (M. C. Z. 7540), 864 (630 + 234) mm.

In coloration M. C. Z. 3112 and 7540 belong to form I, part 1, of Smith (1943, pp. 295–6). M. C. Z. 3887 and 15716 are of form I, part 2 (*sancti-johannis*), while M. C. Z. 3193 and 3855 are nearest to form II (*flavipunctata* of the Indo-Chinese region from Assam eastwards).

### Natrix himalayana (Günther)

*Tropidonotus himalayanus* Günther, 1864, Rept. Brit. India, p. 265, pl. xxii, fig. H: Sikkim and Nepal, India.

♀ (M. C. Z. 3896) "near Madras" (R. H. Beddome) N. D.
♀ (M. C. Z. 22386) Darjeeling (Brit. Mus.) 1926.

Midbody scale-rows 19; ventrals 163–168; anals 2; subcaudals 81–87; upper labials 8 (4, 5); loreal 1; preocular 1; postoculars 3; temporals 1 + 1, 1 + 2, and 2 + 2. Total length of ♀ (M. C. Z. 22386), 695 (530 + 165) mm.

The locality of M. C. Z. 3896 is placed in quotes as probably wrong for, if correct, it would increase the range of this species very greatly.

### Natrix subminiata (Schlegel)

*Tropidonotus subminiatus* Schlegel, 1837, Phys. Serp., 2, p. 313: Java.

♀ (M. C. Z. 7233) Samaguting, Assam (Capt. Butler) 1908.

Midbody scale-rows 19; ventrals 169; anals 2; subcaudals 78; upper labials 8 (3, 4, 5) on the left, 9 (4, 5, 6) on the right; loreal 1; preocular 1; postoculars 2; temporals 2 + 2. Total length of ♂, 932 (700 + 232) mm.

This specimen is apparently referable to the rather doubtful race *N. s. helleri* Schmidt, as defined by Smith (1943, p. 303).

### Natrix stolata stolata (Linnaeus)

*Coluber stolatus* Linnaeus, 1758, Syst. Nat. (ed. 10), **1**, p. 219; and 1766 (ed. 12), **1**, p. 379: Asia.

♀ ♀ (M. C. Z. 3111, 3185) Calcutta (W. Theobald) 1866.
4 ♂ ♂, ♀ ♀, juv. (M. C. Z. 3871, 3889) near Madras (R. H. Beddome) N. D.
♂, 3 ♀ ♀ (M. C. Z. 4267) Ambala (M. M. Carleton) 1877.
♀ (M. C. Z. 7534) Lucknow (T. Barbour) 1907.

Midbody scale-rows 19; ventrals 123–152; anals 2; subcaudals 54–80; upper labials 6 (2, 3), 7 (2, 3, 4), 7 (3, 4), 7 (3, 4, 5), 8 (3, 4, 5,), 8 (4, 5), and 9 (4, 5, 6), the third and fifth arrangements being most frequent with each appearing five times; loreal 1; preocular 1; postoculars 3, except M. C. Z. 4267A, which has 4 on the right side; temporals 1 + 1, 1 + 2, or 1 + 3 (latter in one instance only). Total length of ♀ (M. C. Z. 3185), 451+(420 + 31+) mm.

My reasons for employing trinomials are explained below.

### Natrix stolata beddomii (Günther)

*Tropidonotus beddomii* Günther, 1864, Rept. Brit. India, p. 269, pl. xxii, fig. E: Nilgiri Hills, India.

♂ ♂, ♀ ♀, juv. (M. C. Z. 3841, 3905, 47898–9) near Madras (R. H. Beddome) N. D.
♂ ♂ (M. C. Z. 6204) Anaimalai Hills (Brit. Mus.) 1888.

Midbody scale-rows 19; ventrals 141–149; anals 2; subcaudals 62–72; upper labials 8 (3, 4, 5) or 8 (4, 5); loreal 1; preocular 1, semidivided on right side of M. C. Z. 6204A; postoculars 3; temporals 1 + 0 (one example only), 1 + 1, and 1 + 2. Total length of ♂ (M. C. Z. 47898), 482 (360 + 122) mm.

The essential differences between *N. stolata* and *N. beddomii* may be discussed according to Boulenger (1890, p. 342) and M. A. Smith (1943, pp. 284 and 303–306) as follows:

1. The internasals are said to be narrowly truncate in *stolata*, allegedly broadly truncate in *beddomii*. However, the internasals are moderately truncate in four *stolata* (M. C. Z. 3871, 3889C), and in two *beddomii* (M. C. Z. 6204A, 6204B).

2. The frontal is identical in shape and proportions in examples of both "species," e.g. *stolata* (M. C. Z. 3889D) and *beddomii* (M. C. Z. 47899).

3. Both ventral and subcaudal counts of *beddomii* are included in those of *stolata* as given by M. A. Smith (1943, pp. 304–306).

4. Bidentate scales are, of course, common to both reptiles.

5. Hemipenes of *stolata* extend only to the eighth subcaudal, while in *beddomii* they reach to the twelfth according to M. A. Smith (loc. cit). However it extends to the twelfth subcaudal and is forked at the tip and spinose in both *stolata* (M. C. Z. 3889E) and *beddomii* (M. C. Z. 47898).

6. Maxillary teeth are said to number 21–24 in *stolata*, 28–34 in *beddomii* according to Dr. Smith (loc. cit). However, careful examination of a *stolata* (M. C. Z. 3889B) revealed 13 teeth, the last one abruptly enlarged and somewhat separated from the rest, but the gaps between the teeth indicated some had been shed and suggested a probable total of 26 teeth. Similarly in a *beddomii* (M. C. Z. 47899) there were also 13 teeth, the last one enlarged and separated from the rest, but in this case the gaps indicated a total of 27 teeth. In both "species" the teeth and their arrangement on the jaw seemed identical.

7. It is in coloration that the greatest difference is to be found, yet the yellow stripe so characteristic of *stolata* is formed merely by the fusion of the lateral yellow spots that one sees in *beddomii*. This stripe is often absent anteriorly in *stolata* so that their front part frequently resembles that of *beddomii*. The stripe is absent in *stolata* hatchlings which are indistinguishable from *beddomii* hatchlings except that the former tend to be more brightly colored. A yellow bar in front of the eye is usually present in *stolata*, but an occasional specimen (M. C. Z. 3889B) may be indistinguishable in this respect from a *beddomii* (M. C. Z. 47899).

### Natrix monticola (Jerdon)

*Tropidonotus monticolus* Jerdon, 1853, Journ. Asiatic Soc. Bengal, **22**, p. 530: Wynaad, India.

♂, ♀ (M. C. Z. 3874, 3909) near Madras (R. H. Beddome) N. D.

Midbody scale-rows 19; ventrals 134–144; anals 2; subcaudals m. & 77; upper labials 8 (3, 4, 5), except on left side of M. C. Z. 3874, where there are 6 (3, 4); loreal 1; preocular 1; postoculars 3, except on right side of M. C. Z. 3909 where there are 4; temporals 2 + 2. Total length of ♀ (M. C. Z. 3909), 599 (430 + 169) mm.

While the coloring of M. C. Z. 3874 is normal, that of M. C. Z. 3909 is uniform dark green above except for a very few yellow flecks on

the flanks. It has a faint yellow line across the head just behind the eyes, but no collar or line across the back of the head; the dots on the frontal are present.

### Macropisthodon plumbicolor (Cantor)

*Tropidonotus plumbicolor* Cantor, 1839, Proc. Zool. Soc. London, p. 54: Malwa (Saugor), Central India.

4 ♂ ♂ (M. C. Z. 3838, 3902) near Madras (R. H. Beddome) N. D.
♂, ♀ (M. C. Z. 6205) Anaimalai Hills, at 4,700 feet (Brit. Mus.) 1888.

Midbody scale-rows 25; ventrals 147–153; anals 2; subcaudals 37–47 (♂ ♂ 41–47, ♀ 37); upper labials 7 (3, 4); loreal 1, or 0 in two specimens; preoculars 2; postoculars 3; temporals 2 + 2 or 2 + 3. Total length of ♀, 643 (565 + 78) mm.

### Atretium schistosum (Daudin)

*Coluber schistosus* Daudin, 1803, Hist. Nat. Rept., 7, p. 132: Type locality unknown.

♂, ♀ (M. C. Z. 1330) Periyakulam, Madura District (D. C. Scudder) 1863.
♂ (M. C. Z. 3907) near Madras (R. H. Beddome) N. D.

Midbody scale-rows 19; ventrals 144–153; anals 2; subcaudals 59–84; upper labials 9 (4, 5); loreal 1; preocular 1; postoculars 3, or 2 on right side of M. C. Z. 3907; temporals 2 + 1 or 2 + 2. Total length of ♀, 588 (468 + 120) mm.

### Trachischium monticola (Cantor)

*Calamaria monticola* Cantor, 1839, Proc. Zool. Soc. London, p. 50: Naga Hills, India.

♂ (M. C. Z. 22382) Shillong, Assam (Brit. Mus.) 1926.

Midbody scale-rows 15; ventrals 122; anals 2; subcaudals 31+ (apparently only a single shield missing); upper labials 6 (3, 4); loreal 1; preocular 1; postoculars 2; temporals 1 + 1. Total length of ♂, 184 (157 + 27) mm.

### Trachischium fuscum (Blyth)

*Calamaria fusca* Blyth, 1854, Journ. Asiatic Soc. Bengal, **23**, p. 288: Darjeeling, India.

♀ (M. C. Z. 7513) Rungeel Valley, Sikkim (unlocated) (T. Barbour) 1906.
♂ (M. C. Z. 7514) Tista Valley, Bhutan Border (T. Barbour) 1906.

Midbody scale-rows 13; ventrals 155; anals 2; subcaudals 35–38; upper labials 6 (3, 4); loreal 1; preocular 1; postocular 1; temporals 1 + 1 or 1 + 2. Total length of ♀, 376 (324+52) mm.

The anal shield is divided in these specimens as in all our examples of *Trachischium*, though M. A. Smith's (1943, p. 321) generic description calls for a single anal.

### Trachischium tenuiceps (Blyth)

*Calamaria tenuiceps* Blyth, 1854, Journ. Asiatic Soc. Bengal, **23**, p. 288: Darjeeling, India.

♂ (M. C. Z. 22388) near Darjeeling (Brit. Mus.) 1926.

Midbody scale-rows 13; ventrals 136; anals 2; subcaudals 41; upper labials 6 (3, 4), loreal 1; preocular 1; postoculars 2; temporals 1 + 1. Total length of ♂, 290 (240 + 50) mm.

### Xylophis perroteti (Duméril & Bibron)

*Platypteryx perroteti* Duméril & Bibron, 1854, Erpét. Gén., **7**, p. 501: Nilgiri Hills, India.

4 ♀ ♀ (M. C. Z. 3847, 3866, 3901) near Madras (R. H. Beddome) N.D.

Midbody scale-rows 13; ventrals 136–147; anal 1; subcaudals 14–22; upper labials 5 (3, 4); loreal 1; preocular 0; postocular 1; temporals 1 + 2. Total length of ♀ (M. C. Z. 3901), 294 (275 + 19) mm.

The sublinguals are separated from the first ventral by two small scales in M. C. Z. 3847, the remaining snakes conform to the illustration given by M. A. Smith (1943, p. 342, fig. 110).

### Boiga ochracea ochracea (Günther)

*Dipsas ochraceus* Günther, 1868, Ann. Mag. Nat. Hist. (4), **1**, p. 425: "Pegu," Burma.

♂ (M. C. Z. 3886) "near Madras" (R. H. Beddome) N. D.

Midbody scale-rows 21; ventrals 225; anal 1; subcaudals 108; upper labials 8 (3, 4, 5); loreal 1; preocular 1; postoculars 2; temporals 2 + 2 (L) or 2 + 3 (R). Total length of ♂, 835 (650 + 185) mm.

The hemipenes of this specimen are spined on the proximal as well as the distal half — contrary to the description in M. A. Smith (1943, p. 347). This snake, although rather faded, was apparently uniform brown in color, as called for in Dr. Smith's key (p. 346), and fails to show the more or less distinct crossbars described on pp. 348–349. The locality of our specimen is presumably incorrect.

### Boiga trigonata (Schneider)

*Coluber trigonatus* Schneider, 1802, in Bechstein's transl. of Lacépede, 4, p. 256, pl. xl, fig. 1: Vizagapatam, India.

♂, ♀ (M. C. Z. 3898) near Madras (R. H. Beddome) N. D.
♀ (M. C. Z. 5401) 70 miles s.w. of Ambala (M. M. Carleton) 1879.
♂ (M. C. Z. 15798) Karachi, Sind (F. Wall) 1921.
♀ (M. C. Z. 46624) Sabathu, Punjab (J. Carleton) N. D.
♀ (M. C. Z. 46888) Karachi, Sind (U. S. Nat. Mus.) 1944.

Midbody scale-rows 21; ventrals 218–237; anal 1; subcaudals 78–88; upper labials 8 (3, 4, 5); loreal 1; preocular 1; postoculars 2, or 3 on right side of M. C. Z. 15798 only; temporals 2 + 2 or 2 + 3. Total length of ♀ (M. C. Z. 5401), 818 (660 + 158) mm.

In showing the 3rd, 4th, and 5th labials entering the orbit, these snakes, like all other Indian specimens of *Boiga* in the collection with one exception, agree with M. A. Smith's (1943, p. 345) fig. C, but not with the accompanying text which states 4th, 5th, and 6th.

### Boiga ceylonensis nuchalis (Günther)

*Dipsas nuchalis* Günther, 1875, Proc. Zool. Soc. London, p. 233: West Coast of India.

♂ (M. C. Z. 3876) near Madras (R. H. Beddome) N. D.
♀ (M. C. Z. 18062) Taliparamba, Madras (F. Wall) 1923.

Midbody scale-rows 21, or 23 in M. C. Z. 18062; ventrals 234–241; anal 1; subcaudals 101–102; upper labials 8 (3, 4, 5); loreal 1; preocular 1; postoculars 2; temporals 2 + 3, 3 + 3, or 3 + 5. Total length of ♂, 671 (522 + 149) mm.

M. C. Z. 18062 was received from Colonel Wall as *nuchalis* and

both of these snakes agree with this form as outlined by Malcolm Smith (1943 p. 352). When Wall (1909 pp. 151–154) split *ceylonensis* into four forms (*ceylonensis, nuchalis, beddomei,* and *andamanensis*) he believed that each was a full species, although in later papers (1924 p. 870 for example) he admitted that their specific rank would probably be denied by most students. On the other hand, when I consider the very large number of examples examined by Colonel Wall (72 of *ceylonensis* and 59 of *nuchalis*) I am inclined to think that he has shown the differences between these forms to be adequately constant to require their subspecific recognition.

### Boiga multifasciata (Blyth)

*Dipsas multifasciatus* Blyth, 1860, Journ. Asiatic Soc. Bengal, **29**, p. 114: Sabathu, Simla, India.

♀ (M. C. Z. 3228) Kulu Valley (M. M. Carleton) 1872.

Midbody scale-rows 21; ventrals 245; anal 1; subcaudals 103; upper labials 8 (3, 4, 5); loreal 1; preoculars 1 or 2; postoculars 2; temporals 2 + 2 or 2 + 3, (1 + 2 or 2 + 3 are characteristic according to M. Smith, 1943, p. 357). This snake is unusual in having only 8 + 2 maxillary teeth since Dr. Smith (loc. cit.) gives 10 or 11 + 2 as the usual range. Total length of ♀, 1112 (890 + 222) mm.

As regards coloration our example has about 85 rather broken up oblique bars on the sides, the bars generally fusing dorsally to form a series of V-shaped marks. The characteristic dorsal white spots are very much reduced and posteriorly they are only indicated by a discontinuous vertebral line.

Dr. Malcolm Smith states (loc. cit.) that the vertebral scales are not strongly enlarged in this species, although Stoliczka (1870, p. 199) mentions the reverse as being true. Our specimen shows moderately strong enlargement anteriorly and strong enlargement on the posterior third of the body. At midbody the scales do not appear to be enlarged, but this is apparently due to the large vertebrals being split into two or three small scales. This phenomenon was noted by Wall (1909 p. 352).

In discussing *B. ceylonensis* both Smith (1943 p. 353) and Wall (1909 p. 153, 1911 p. 279, 1919 p. 571, and 1924 p. 872) mention a few specimens of this species, as coming from localities (Orissa, Nepal and Assam) far north of the usual range. Both authors note the rarity of these records, the species being very common in South

India and Ceylon, and Smith expresses doubt as to the identification of these northern specimens. The two juveniles from Nepal (apparently the only northern examples examined by Dr. Smith) are described by him (loc. cit.) as having 21 midbody scale-rows; only 2 anterior temporals; and a different color pattern, the vertebral spots being absent and in their place a series of transverse or oblique bars. A similar color pattern is described for the Orissa specimen by Wall (1911 p. 279). All of these points seem to characterize *multifasciata* rather than *ceylonensis*. The only other characters given by Dr. Smith as differentiating these two species seem to be the enlargement of the vertebrals (strongly in *ceylonensis*, not strongly in *multifasciata*), a point already discussed; a slight difference in the number of maxillary teeth (10 or 11 + 2 in *multifasciata*, 12 to 20 + 2 in *ceylonensis*); and the presence of dorsal white spots in *multifasciata*, though they may be very much reduced, as in our example.

I think, therefore, that the northern specimens known as *ceylonensis* are probably the Himalayan *multifasciata* and that *ceylonensis* (including its subspecies) is confined to the hills of South India, Ceylon, and the Andaman Islands.

Our specimen is a gravid female with nine eggs measuring 35 x 18 mm. on the average.

### Boiga forsteni (Duméril & Bibron)

*Triglyphodon forsteni* Duméril & Bibron, 1854, Erpét. Gén., **7**, p. 1077: Type locality unknown.

♀ (M. C. Z. 22383) India (Brit. Mus.) 1926.

Midbody scale-rows 27; ventrals 265; anal 1; subcaudals 102; upper labials 9 (3, 4, 5) on left, 10 (4, 5, 6) on right; loreal 1; preocular 1; postoculars 2; temporals 3 + 3, or 3 + 4. Color uniform. Total length of ♀, 1283 (1030 + 253) mm.

### Psammophis leithii Günther

*Psammophis leithii* Günther, 1869, Proc. Zool. Soc. London, p. 505, pl. xxxix: Sind, India.

♂ (M. C. Z. 3151) Ambala (M. M. Carleton) N. D.

Midbody scale-rows 17; ventrals 170; anal 1; subcaudals 47+; upper labials 8 (4, 5); loreal 1; preocular 1; postoculars 2; temporals 1 + 2. Total length of ♂, 610+ (490 + 120+) mm.

### Psammodynastes pulverulentus (Boie)

*Psammophis pulverulenta* Boie, 1827, Isis von Oken, p. 547: Java.

♂ (M. C. Z. 3891) near Madras (R. H. Beddome) N. D.

Midbody scale-rows 17; ventrals 159; anal 1; subcaudals 61; upper labials 8 (3, 4, 5); loreal 1; preoculars 2; postoculars 2; temporals 2 + 2. Total length of ♂, 433 (340 + 93) mm.

### Dryophis perroteti (Duméril & Bibron)

*Psammophis perroteti* Duméril & Bibron, 1854, Erpét. Gén., **7**, p. 899: "Indes Orientales."

♂ ♂, ♀ ♀ (M. C. Z. 3859, 3878, 3900) near Madras (R. H. Beddome) N. D.

♀, juv. (M. C. Z. 4180) "Pegu, Burma" (E. Gerrard) 1877.

Midbody scale-rows 15; ventrals 138–143; anals 2; subcaudals 65–80; upper labials 8 (4, 5); loreal 0; preocular 1; postocular 1; temporals 1 + 2. Total length of ♀ (M. C. Z. 4180), 558 (420 + 138) mm.

As might be expected the males show more subcaudals (76–80) than do the females (65–71) though M. A. Smith (1943, p. 373) gives the females more (71–86) than the males (65–75). The coloration of three specimens is the usual green (blue in alcohol), while the other three are olive brown above, as in Dr. Smith's specimen from the Nilgiri Hills. The locality on M. C. Z. 4180 is almost certainly erroneous.

### Dryophis dispar (Günther)

*Tragops dispar* Günther, 1864, Rept. Brit. India, p. 303, pl. xxiii, fig. A: Anaimalai Hills, India.

♀ (M. C. Z. 33516) Kodaikanal, Palni Hills (Senckenberg Mus.) 1932.

♀, ♂ (M. C. Z. 48800, 48953) near Madras (R. H. Beddome) N. D.

Midbody scale-rows 15; ventrals 143–150; anals 2; subcaudals 86–112; upper labials 8 (4, 5) and no pre-subocular in M. C. Z. 48953, 8 (5) with 2 pre-suboculars in M. C. Z. 48800, 7 (4) on right and 6 (3) on left side with 1 pre-subocular in M. C. Z. 33516; loreals 1–2; preocular 1; postoculars 2; temporals 1 + 2 or 2 + 2. Total length of ♀ (M. C. Z. 33516), 617 (445 + 172) mm.

The internasals are separated from the labials in M. C. Z. 48953 and 33516, while they are in contact in M. C. Z. 48800.

### Dryophis fronticinctus Günther

*Dryophis fronticinctus* Günther, 1858, Cat. Col. Snakes Brit. Mus., p. 158: Type locality unknown.

♀ (M C Z 18394) no locality (W. N. Parker) 1924.

Midbody scale-rows 15; ventrals 188; anals 2; subcaudals 77+; upper labials 8 (5) with 2 large and 1 small pre-suboculars; loreals 2; preocular 1 (in contact with frontal); postoculars 2; temporals 2 + 3. Total length of ♀, 800+ (600 + 200+) mm.

Nasals well-separated, *not* in contact behind the rostral. This snake was given by Günther to Prof. W. N. Parker for help given the British Museum; Parker gave it to A. Loveridge who brought it to the Museum of Comparative Zoölogy.

### Dryophis nasutus (Lacépède)

*Coluber nasutus* Lacépède, 1789, Hist. Nat. Serp., **2**, pp. 100, 277, pl. iv, fig. 2: Ceylon (restricted).

head, ♂ (M. C. Z. 3899) near Madras (R. H. Beddome) N. D.
head (M. C. Z. 4754) Calcutta (No further data).

Midbody scale-rows 15; ventrals 185; anals 2; subcaudals 177+; upper labials 8 (5); pre-suboculars 1–2; loreal 0; preocular 1; postoculars 2; temporals 1 + 2, 2 + 2, 2 + 3, or 2 + 4. Total length of ♂, 429+ (275 + 154+) mm.

### Dryophis pulverulentus (Duméril & Bibron)

*Dryinus pulverulentus* Duméril & Bibron, 1854, Erpet. Gén., **7**, p. 812: Type locality unknown.

head (M. C. Z. 3906) near Madras (R. H. Beddome) N. D.

Nasals not in contact; upper labials 8 (5);pre-suboculars 2; loreal 0; preocular 1; postoculars 2; temporals 2 + 3.

### Enhydris enhydris (Schneider)

*Hydrus enhydris* Schneider, 1799, Hist. Amphib., **1**, p. 245: "Indiae orientalis."

♀ (M. C. Z. 3192) Calcutta (W. Theobald) 1866.

Midbody scale-rows 21; ventrals 161; anals 2; subcaudals 61; upper labials 8 (4); loreal 1; preocular 1; postocular 2; temporals 1 + 2. Total length of ♀, 470 (381 + 89) mm.

In color pattern this snake conforms to group 1 of M. A. Smith (1943, p. 384).

### Enhydris sieboldii (Schlegel)

*Homalopsis sieboldii* Schlegel, 1837, Phys. Serp., **2**, p. 349, pl. xiii, figs. 4–5: Bengal, India.

♀ (M. C. Z. 22384) Fyzabad, United Provinces (Brit. Mus.) 1926.

Midbody scale-rows 29; ventrals 148; anals 2; subcaudals 50; upper labials 8 (4), the last two horizontally divided; loreal 1; preoculars 1 (R) or 2 (L); postoculars 2; temporals 1 + 2 (R) or 1 + 3 (L). Total length of ♀, 441 (365 + 76) mm.

### Cerberus rhynchops (Schneider)

*Hydrus rhynchops* Schneider, 1799, Hist. Amph., **1**, p. 246: Ganjam, India.

♂ (M. C. Z. 2229) Pondichéry (Paris Mus.) 1865.
♂ (M. C. Z. 5501) Calcutta (Peabody Mus., Salem) 1886.
♀ (M. C. Z. 5589) Calcutta (C. Williams) 1886.

Midbody scale-rows 23–25; ventrals 147–154; anals 2; subcaudals 54–63; nostril connected by suture with second (not first) labial in M. C. Z. 5501; upper labials 10, none entering orbit, last two or three horizontally divided; loreal 1; preocular 1; suboculars 2; postoculars 2; temporals 1 + 2 (in M. C. Z. 2229), broken up and scale-like in others. Total length of ♂ (M. C. Z. 5501), 550 (440 + 110) mm.

## ELAPIDAE

### Bungarus fasciatus (Schneider)

*Pseudoboa fasciata* Schneider, 1801, Hist. Amphib., **2**, p. 283: Bengal, India.

♂ (M. C. Z. 3108) Calcutta (W. Theobald) 1866.

Midbody scale-rows 15; ventrals 210; anal 1; subcaudals 39; upper labials 7 (3, 4); loreal 0; preocular 1; postoculars 2; temporals 1 + 2. Coloration normal. Total length of ♂, 1510 (1360 + 150) mm.

### Bungarus caeruleus (Schneider)

*Pseudoboa caerulea* Schneider, 1801, Hist. Amphib., **2**, p. 284: Vizagapatam, India.

♂ (M. C. Z. 3213) Ambala (M. M. Carleton) 1886.
♂ (juv.) (M. C. Z. 7572) Lucknow (T. Barbour) 1906.
♂ (M. C. Z. 18060) Taliparamba, Madras (F. Wall) 1924.
♂, ♂ (juv.) (M. C. Z. 46623, 46625) Sabathu, Punjab (J. Carleton) N. D.

Midbody scale-rows 15; ventrals 207–214; anal 1; subcaudals 40–51, the increase of 2 in the recognized range is due to a male (M. C. Z. 18060); upper labials 7 (3, 4) or 8 (4, 5) on left side of M. C. Z. 46625 only; loreal 0, except for M. C. Z. 46623 which is remarkable in having a loreal split off from the first labial on each side, preocular 1; postoculars 2; temporals 1 + 2. Total length of ♂ (M. C. Z. 46623), 990 (850 + 140) mm.

Considerable variation in color pattern is to be noted. In M. C. Z. 3213 there are no bars on the anterior portion, distinct paired bars being present on the tail only, they scarcely widen on the sides and, anteriorly in particular, there is a fairly prominent vertebral spot. In M. C. Z. 7572 the bars are more distinctly paired, widen a little laterally, and are otherwise as in M. C. Z. 3213. In M. C. Z. 18060 the bars are distinctly paired, some pairs being almost fused posteriorly, they widen considerably on the sides, particularly anteriorly; there are prominent vertebral spots. M. C. Z. 46625 is similar to M. C. Z. 7572, while M. C. Z. 46623 has rather faint bars with very little lateral widening; the vertebral spots are well defined.

### Calliophis nigrescens (Günther)

*Callophis nigrescens* Günther, 1862, Ann. Mag. Nat. Hist. (3), **9**, p. 131: India.

♀ (M. C. Z. 3837) near Madras (R. H. Beddome) N. D.

Midbody scale-rows 13; ventrals 230; anal 1; subcaudals 32; upper labials 7 (3, 4); loreal 0; preocular 1; postoculars 2; temporals 1 + 2. Total length of ♀, 770 (700 + 70) mm.

The above counts increase the ventral range by 4; the specimen is also unusual in having an undivided anal. In coloration it approaches closest to form II of M. A. Smith (1943, p. 422), but the stripes are not black, only a deeper shade of the same purplish brown as the rest of the body. On the posterior half the white stripes practically disappear, as in Smith's form III.

As there appears to be no valid reason for changing Gray's spelling of *Calliophis* to Günther's emendation, *Callophis*, used by Dr. Smith, I adhere to the original form.

### Calliophis macclellandii (Reinhardt)

*Elaps macclellandii* Reinhardt, 1844, Calcutta Journ. Nat. Hist., **4**, p. 532: Assam, India.

♀ (M. C. Z. 22390) Shillong, Assam (Brit. Mus.) 1926.

Midbody scale-rows 13; ventrals 213; anals 2; subcaudals 30; upper labials 7 (3, 4); loreal 0; preocular 1; postoculars 2; temporals 1 + 1. Total length of ♀, 514 (465 + 49) mm.

Only slight traces of the black vertebral line remain, and the black crossbars, though rather reduced, are not broken up into transverse rows of spots. The belly is much splotched with black.

### Naja naja naja (Linnaeus)

*Coluber naja* Linnaeus, 1758, Syst. Nat. (ed. 10), **1**, p. 221: India.

♂ (M. C. Z. 1331) Periyakulam, Madura District (W. C. Scudder) 1843.
♀ (M. C. Z. 3229) Kulu Valley (M. M. Carleton) 1871.
♀ ♀ (M. C. Z. 3518–9) India (from charmers. M. M. Carleton) 1871.
♀ (M. C. Z. 5268) 70 miles s. w. of Ambala (M. M. Carleton) 1879.
♂ (M. C. Z. 7564) Lucknow (T. Barbour) 1907.

In addition there are several mounted specimens and skeletons on exhibition.

Midbody scale-rows 21–23; ventrals 187–191; anal 1; subcaudals 55–61; upper labials 7 (3, 4); loreal 0; preocular 1; postoculars 3; temporals 2 + 2, 2 + 3 (normally), or 2 + 4. Total length of ♀ (M. C. Z. 3519), 1510 (1270 + 240) mm.

In coloration M. C. Z. 1331 is pale above with very little reticulation, has no black bars on the belly, but exhibits clearly the spectacle mark of Smith's (1943, p. 433) form C. M. C. Z. 3229 is darker with

reticulation resulting from the dark-edged scales and pale interstitial skin. It has no bars on the belly, and the U-shaped spectacle mark is faint. M. C. Z. 5268 is medium brown with little reticulation, no bars on the belly, and the U-shaped spectacle mark is very faint. M. C. Z. 7564 is blackish above and below with only indistinct traces of a spectacle mark. M. C. Z. 3518 is palish brown anteriorly, blackish posteriorly. Bars are present on the belly and there is a fairly distinct spectacle. M. C. Z. 3519 is blackish, paler anteriorly and shows very little trace of the spectacle mark.

### Naja naja kaouthia Lesson

*Naja kaouthia* Lesson, 1831, in Ferussac, Bull. Sci. Nat., **25**, p. 122: Bengal, India.

♂ (M. C. Z. 4228) India (E. Gerrard) 1877.

Midbody scale-rows 21; ventrals 177; anal 1; subcaudals 52; upper labials 7 (3, 4); loreal 0; preocular 1; postoculars 3; temporals 2 + 3. Color normal in every way as in M. A. Smith (1943, p. 431), the monocellate mark on hood conforming to G of Smith (1943, p. 433). Total length of ♂, 1495 (1265 + 230) mm.

## HYDROPHIIDAE

### Laticauda colubrina (Schneider)

*Hydrus colubrinus* Schneider, 1799, Hist. Amphib., **1**, p. 238: Type locality unknown.

♀ (M. C. Z. 4177) Indian Seas (E. Gerrard) 1877.
♂ (M. C. Z. 4834) Indian Seas (Boston Soc. Nat. Hist.) 1880.

Maximum scale-rows 23–25; ventrals 227–233; anals 2; subcaudals 34–43; upper labials 7 (3, 4); loreal 0; preocular 1; postoculars 2; temporals 1 + 2; M. C. Z. 4834 is abnormal in lacking an azygous prefrontal. Coloration of this snake is, however, normal with 34 crossbars or bands; there are 30 bands in M. C. Z. 4177 but the black head-marking does not coalesce with even the first nuchal band. Total length of ♀, 463 (415 + 48) mm.

Scale-counts of M. C. Z. 4834, but not of M. C. Z. 4177, are included in Dr. M. A. Smith's (1926, p. 9) "Monograph of the Sea-snakes."

### Kerilia jerdoni Gray

*Kerilia jerdoni* Gray, 1849, Cat. Sn. Brit. Mus., p. 57: Madras, India.

♂ (M. C. Z. 5207) Madras Coast (H. A. Ward) 1884.

Maximum scale-rows 21 (19 in Smith); ventrals 225; anals 2; upper labials 6 (3, 4); loreal 0; preocular 1; postocular 1; temporals 1 + 1, the anterior being confluent with the 6th labial. Coloration normal with 38 crossbars. Total length of ♂, 806 (720 + 86) mm.

These scale-counts are included in M. A. Smith's (1926, p. 32) "Monograph of the Sea-snakes," but the race *siamensis* he describes there was subsequently relegated to the synonymy by him (1943, p. 447).

### Enhydrina schistosa (Daudin)

*Hydrophis schistosus* Daudin, 1803, Hist. Nat. Rept., **7**, p. 386: Tranquebar, India.

♀ (M. C. Z. 23514) Karachi (M. A. Smith) 1927.
♀ (juv.) (M. C. Z. 23515) Bombay (M. A. Smith) 1927.

Maximum scale-rows 61–63; ventrals 299–329; anals 2; upper labials 8 (3, 4); loreal 0; preocular 1 and 0; postocular 1; temporals 1 + 3 or 2 + 3. M. C. Z. 23515 is abnormal in having the prefrontals only slightly narrowed anteriorly; there is no preocular; and there are two small supernumary scales on either side of the parietal suture. Its coloration, with 54 crossbars, not complete bands, is normal for a juvenile, while that of M. C. Z. 23514 is normal for an adult. Total length of ♀ (M. C. Z. 23514), 889 (780 + 109) mm.

Scale-counts of these examples are not included in M. A. Smith's (1926, pp. 39–40) "Monograph of the Sea-snakes."

### Hydrophis spiralis (Shaw)

*Hydrus spiralis* Shaw, 1802, Gen. Zool., **3**, p. 564, pl. cxxv: Indian Ocean.

♂ (M. C. Z. 9599) near Madras (R. H. Beddome) N. D.
♀ (M. C. Z. 10257) Indian Seas (Australian Mus.) 1914.

Maximum scale-rows 35 (33 according to Smith (1926, p. 50) for M. C. Z. 9599); ventrals 326–356; anals 2; upper labials 6 (3, 4) or 7 (3, 4); loreal 0; preocular 1; postoculars 1–2; temporals 1 + 2. In color both specimens are normal. M. C. Z. 9599 has 47 bars on

its body; 41–46 are usual for examples from Indian waters according to M. A. Smith (1943, p. 453). M. C. Z. 10257 has a pronounced dark ventral line. Total length of ♀, 542 (500 + 42) mm.

Except where noted, Dr. M. A. Smith has examined all our specimens of Hydrophiidae and included their scale-counts in his (1926) "Monograph of the Sea-snakes." Unless specifically mentioned my counts agree with his.

### Hydrophis cyanocinctus Daudin

*Hydrophis cyanocinctus* Daudin, 1803, Hist. Nat. Rept., **7**, p. 383: Sandarbans, India.

♀ (M. C. Z. 23611) Karachi (M. A. Smith) 1927.

Maximum scale-rows 45; ventrals 341; anals 2; upper labials 7 (3, 4); loreal 0; preocular 1; postoculars 2; temporals 2 + 2 or 2 + 3; frontal abnormal in being shorter than its distance from the rostral. In coloration the annuli are complete and a ventral stripe is present. Total length of ♀, 1365 (1250 + 115) mm.

Dr. M. A. Smith (1926, p. 58) mentions this snake, but omits its scale-counts.

### Hydrophis obscurus Daudin

*Hydrophis obscura* Daudin, 1803, Hist. Nat. Rept., **7**, p. 375: Sandarbans, India.

♀ (M. C. Z. 23669) Chilka Lake, Orissa (M. A. Smith) 1927.

Maximum scale-rows 33; ventrals 300; anals 2; upper labials 7 (3, 4); loreal 0; preocular 1; postocular 1; temporals 1 + 2. Color normal with 37 bars on the body. Total length of ♀, 762 (690 + 72) mm.

### Hydrophis stricticollis Günther

*Hydrophis stricticollis* Günther, 1864, Rept. Brit. India, p. 376, pl. xxv, fig. R: India.

♂ (M. C. Z. 23673) Dhamoa River, Orissa (unlocated) (M. A. Smith) 1927.

Maximum scale-rows 46; ventrals 419; anals 2; upper labials 7 (3, 4); loreal 0; preocular 1; postoculars 1 (L) or 2 (R); temporals 1 + 3. The coloration is normal with about 51 crossbars. Total length of ♂, 1140 (1000 + 140) mm.

The locality may easily be the Dhamra River in Orissa.

### Hydrophis ornatus ornatus (Gray)

*Aturia ornata* Gray, 1842, Zool. Misc., p. 61: Indian Ocean.

♀ (M. C. Z. 5209) Madras Coast (H. A. Ward) 1884.

Maximum scale-rows 47; ventrals 312; anals 2; upper labials 7 (3, 4) or 8 (3, 4); loreal 0; preocular 1; postoculars 2; temporals 2 + 2 or 2 + 5. Coloration normal. Total length of ♀, 840 (750 + 90) mm.

### Hydrophis mamillaris (Daudin)

*Anguis mamillaris* Daudin, 1803, Hist. Nat. Rept., **7**, p. 340: Vizagapatam, India.

♂ (M. C. Z. 23663) Bombay (M. A. Smith) 1927.

Maximum scale-rows 39; ventrals 340; anals 2; upper labials 7 (3, 4); loreal 0; preocular 1; postoculars 2; temporals 2 + 3. Its color pattern includes a yellow streak in the temporal region and 44 ventrally connected bands. Total length of ♂, 715 (650 + 65) mm.

### Hydrophis fasciatus fasciatus (Schneider)

*Hydrus fasciatus* Schneider, 1799, Hist. Amphib., **1**, p. 240: East Indies.

♂ (M. C. Z. 23627) Bengal (M. A. Smith) 1927.

Maximum scale-rows 51, decreasing to 29 on neck; ventrals 487; anals 2; upper labials 6 (3, 4); loreal 0; preocular 1; postoculars 1–2; temporals 1 + 2. Coloration normal with 74 crossbars, *not* complete bands. Total length of ♂, 777 (710 + 67) mm.

### Astrotia stokesii (Gray)

*Hydrus stokesii* Gray, 1846, in Stokes, Discov. Australia, **1**, p. 502, pl. iii: Australian Seas.

♂ (M. C. Z. 23499) Indian Ocean (M. A. Smith) 1927.

Maximum scale-rows 49; ventrals 254; anals 2; upper labials 8 (4, 5, 6); loreal 0; preocular 1; postoculars 2; temporals 2 + 5 or 3 + 4. Coloration normal with 33 complete bands. Total length of ♂, 1227 (1050 + 177) mm.

Dissection shows that this snake is undoubtedly a male though listed as a female by Dr. Smith (1926, p. 115).

### Microcephalophis gracilis gracilis (Shaw)

*Hydrus gracilis* Shaw, 1802, Gen. Zool., **3**, p. 560: Type locality unknown.

juv. (M. C. Z. 5213) Madras Coast (H. A. Ward) 1884.
♂ (M. C. Z. 23796) India (M. A. Smith) 1927.

Maximum scale-rows 35; ventrals 252–259; anals 2; upper labials 6 (3, 4); loreal 0; preocular 1; postocular 1; temporals 1 + 1. M. C. Z. 5213 has oval spots anteriorly and 47 or 48 dorsal bands; in M. C. Z. 23796 the bands are extremely faint, particularly posteriorly. Total length of ♂, 765 (700 + 65) mm.

Scale-counts of these specimens are not included in Dr. Smith's (1926, p. 123) "Monograph of the Sea-snakes."

### Microcephalophis cantoris (Günther)

*Hydrophis cantoris* Günther, 1864, Rept. Brit. India, p. 374: "Penang."

♂, ♀ (M. C. Z. 5206, 5208) Madras Coast (H. A. Ward) 1884.
♂ (M. C. Z. 23795) Karwar, West Coast of India (M. A. Smith) 1927.

Maximum scale-rows 44–46 (41–44 in Smith); ventrals 416–447; anals 2; upper labials 6 (3, 4); loreal 0; preocular 1; postocular 1; temporals 1 + 1 or 1 + 2. Coloration normal; 53–65 bars on body and tail, and a dark ventral line. Total length of ♀ (M. C. Z. 5208), 1075 (990 + 85) mm.

Dissection shows M. C. Z. 5208 to be a female though listed as a male by Dr. Smith (1926, p. 126).

### Pelamis platurus (Linnaeus)

*Anguis platurus* Linnaeus, 1766, Syst. Nat. (ed. 12), **1**, p. 391: Type locality unknown.

♀ (M. C. Z. 922) Bay of Bengal (J. M. Barnard) 1862.
♂ (M. C. Z. 4226) Indian Seas (E. Gerrard) 1886.

Maximum scale-rows 53–57; ventrals 330–338; anals 2; upper labials 7–8, separated from the orbit by suboculars; loreal 0; preocular 1; postoculars 2–3; temporals 3 + 5 or 4 + 3. In coloration M. C. Z. 922 conforms to form III and M. C. Z. 4226 to form I of M. A. Smith (1943, p. 476). Total length of ♂, 629 (550 + 79) mm.

Scale counts of these specimens are not included in Dr. Smith's (1926, pp. 119–120) "Monograph of the Sea-snakes."

## VIPERIDAE

### Vipera russelli russelli (Shaw)

*Coluber russelli* Shaw, 1797, Nat. Misc., **8**, pl. ccxci: Type locality unknown.

juv. (M. C. Z. 4193) India (E. Gerrard) 1877.
♂ (M. C. Z. 18405) India (A. Loveridge) 1924.
juv. (M. C. Z. 46627) Sabathu, Punjab (J. Carleton) N. D.

Midbody scale-rows 29; ventrals 166–169; anal 1; subcaudals 47–49; upper labials 11; 3 scales between labials and eye; 11–14 scales around eye; 2 scales between eye and nasal; nasorostral present; temporals broken up and scale-like. Coloration normal. Total length of ♂, 956 (810 + 146) mm.

Whether all the above material should be assigned to the typical form is uncertain in view of the poor locality data and the very slight racial characters assigned to the alleged subspecies described by Deraniyagala (1945, pp. 110–112).

### Echis carinatus carinatus (Schneider)

*Pseudoboa carinata* Schneider, 1801, Hist. Amphib., **2**, p. 285 (based on Russell): Arni, India.

3 ♂ ♂, 2 juv. (M. C. Z. 3843, 3882, 3888) near Madras (R. H. Beddome) N. D.

Midbody scale-rows 27–29; ventrals 139–154; anal 1; subcaudals 23–33; upper labials 8–10, none entering the orbit; circumorbital scales exclusive of supraocular 9–11; supraoculars separated by 8–9 scales; usually a single (2 on one side in one specimen) scale between the eye and labials; 3 scales between the eye and nasal. Total length of ♂ (M.C.Z. 3843), 333 (290 +43) mm.

My reasons for using trinomials are given below.

### Echis carinatus pyramidum (Geoffroy)

*Scythale pyramidum* Geoffroy, 1827, Descr. Égypte, Rept., p. 152, pl. vii, fig. 1: Egypt.

♂ (M. C. Z. 3226) Bengal (M. M. Carleton) 1869.
♀ (M. C. Z. 3765) Ambala (M. M. Carleton) N. D.
3 ♂ ♂ (M. C. Z. 5405) 100 miles south of Ambala (M. M. Carleton) 1879.

2 juv. (M. C. Z. 15805–6) Karachi (F. Wall) 1921.
♂ (M. C. Z. 46626) Karauli District, Rajputana (J. Carleton) N. D.

Midbody scale-rows 31–35; ventrals 162–172; anal 1; subcaudals 27–31; upper labials 10–12, none entering the orbit; circumorbital scales exclusive of supraocular 11–15; supraoculars separated by 9–12 scales (9 in one specimen only); 2 scales between the eye and labials; 4 scales between the eye and nasal. Total length of ♂ (M. C. Z. 3226), 467 (420 + 47) mm.

In examining our series of the saw-scaled viper it soon became clear that two distinct races were present. Typical specimens from Madras show considerably reduced scale counts — particularly on the head — as compared with snakes from northern India, Arabia, Egypt, and presumably elsewhere in North Africa. These differences can best be seen when contrasted as follows:

| *Squamation* | *Madras* | *North India* |
|---|---|---|
| Midbody scale-rows | 27–29 | 31–35 |
| Ventrals | 139–154 | 162–172 |
| Upper labials | 8–10 | 10–12 |
| Circumorbitals excluding supraocular | 9–11 | 11–15 |
| Scales separating supraoculars | 8–9 | 9–12 |
| Scales separating eye from labials | 1 (very rarely 2) | 2 |
| Scales separating eye from nasal | 3 | 4 |

Dr. Malcolm Smith, who (1943, p. 488) had already noted the difference in midbody scale-rows, kindly supplied scale counts taken from four specimens in the British Museum, and these confirmed the opinion already arrived at.

The problem arose as to which race was originally figured by Russell, as it is impossible to tell this from his plate, and the figured specimen is no longer in existence according to Dr. Smith. However, the locality (Arni) from which it came is so close to Madras that it is fair to assume that this was the form subsequently named *E. carinatus* by Schneider. In seeking a name for the race inhabiting Northern India, Persia, Arabia, and North Africa, I found that *Echis ziczac* Gray is the earliest name not based on Russell, according to the synonomy of *Echis carinatus* in M. Smith (1943 p. 487). However, this name was not founded on actual specimens but is based on *E. zic zac* Daudin and *Boa horrata* Schneider. The next available name is *Scythale pyramidum* Geoffroy which must antedate *E. arenicola* Boie since, in his description, Boie mentions Geoffroy's description.

## CROTALIDAE

### Agkistrodon himalayanus (Günther)

*Halys himalayanus* Günther, 1864, Rept. Brit. India, p. 393, pl. xxiv, fig. A: Garhwal, W. Himalayas, India.

13 ♂ ♂, 7 ♀ ♀ (M. C. Z. 3138–40, 3143, 3149, 3227, 3230, 4023, 4800) Kulu Valley (M. M. Carleton) 1874.
♀ (M. C. Z. 3150) Ambala (M. M. Carleton) 1873.

Midbody scale-rows 21; ventrals 153–162 (♂ ♂), 160–166 (♀ ♀); anal 1; subcaudals 43–51 (♂ ♂), 38–45 (♀ ♀); upper labials 6–7 (3); loreal 1; preoculars 2; subocular 1; postoculars 1–2 (2 on right side of M. C. Z. 3140 only); temporals 1 + 3, 1 + 4, 2 + 3, or 2 + 4, always with 3 large inferior ones. Total length of ♂ (M. C. Z. 3139B), 595 (505 + 90) mm., of ♀ (M. C. Z. 3139A), 541 (470 + 71) mm.

One female (M. C. Z. 3230) is gravid with 7 eggs in the oviducts.

### Agkistrodon hypnale (Merrem)

*Cophias hypnale* Merrem, 1820, Syst. Amph., p. 155: Ceylon

♂ ♀ (M C Z 3879, 3894) near Madras (R H. Beddome) N.D.
♂, 3 ♀ ♀ (M. C. Z. 18067–9) Taliparamba, Madras (F. Wall) 1923.

Midbody scale-rows 17; ventrals 136–150; anal 1; subcaudals 33–46; upper labials 7 (0); loreal 1; preoculars 2; subocular 1; postocular 1; temporals 2 + 3, 2 + 4, 2 + 5, 3 + 3 or 3 + 4. Total length of ♀ (M. C. Z. 18067), 370 (323 + 47) mm.

### Trimeresurus macrolepis Beddome

*Trimeresurus macrolepis* Beddome, 1862, Madras Quart. Journ. Med. Sci., **5**, p. 2, pl. ii, fig. 6: Anaimalai Hills, India.

♀, ♀ ?, head (M. C. Z. 3864, 3890) near Madras (R. H. Beddome) N. D.

Midbody scale-rows 12–16; ventrals 135–144; anal 1; subcaudals 50–51; upper labials 7–8 (0); loreal 1; preoculars 2; subocular 1; postocular 1; temporals 2 + 2, 2 + 3 or 2 + 4. Total length of ♀ ? (M. C. Z. 3890), 340 (277 + 63) mm.

In M. C. Z. 3864 the supraoculars are separated by a large scale with a smaller one on either side of it. The internasals are separated in this

snake, a condition not found in the other specimens. All three examples are apparently unusual in having two or three labials directly in contact with the subocular, while M. A. Smith (1943, p. 505) states: "a single series of scales between the labials and the elongate subocular." Furthermore, Dr. Smith (1943, p. 502) cites two or three postoculars as a generic character but each of our three snakes has only a single postocular.

### Trimeresurus malabaricus (Jerdon)

*Trigonocephalus* (*Cophias*) *malabaricus* Jerdon, 1853, Journ. Asiatic Soc. Bengal, **22**, p. 523: Western Ghats, India.

♂ ♂, ♀ ♀ (M.C.Z. 3845–6, 3851, 3883) near Madras (R.H. Beddome) N.D.

Midbody scale-rows 19–21; ventrals 144–149 (♂ ♂), 140–148 (♀ ♀); anal 1; subcaudals 58–60 (♂ ♂), 53 (♀); upper labials 8–10 (0); loreal 1; preoculars 2; subocular 1; postoculars 2; temporals broken up and scale-like; 7–8 scales separating supraoculars; a single series between the labials and subocular. Total length of ♀ (M. C. Z. 3883), 458 (383 + 75) mm.

### Trimeresurus albolabris Gray

*Trimeresurus albolabris* Gray, 1842, Zool. Misc., p. 48: China.

♂, ♀ ♀, head (M. C. Z. 4369, 4490) Ambala (M. M. Carleton) 1878.

Midbody scale-rows 21–23; ventrals 168; anal 1; subcaudals 75 (♂), 60–64 (♀ ♀); upper labials 10–11 (0); loreal 1; preoculars 2; subocular 1; postoculars 2–3; temporals broken up and scale-like; 11–12 scales separating supraoculars; a double series of scales between the labials and subocular. Total length of ♂ (M. C. Z. 4490), 637 (500 + 137) mm.

This ♂ (M. C. Z. 4490) is of importance in having 23 midbody scale-rows and the more numerous subcaudals characterizing *T. erythrurus*. On the other hand it possesses the smooth temporals of *albolabris* and agrees with that species in having little or no brown coloring on the tail. The locality is well to the west of any record of *erythrurus*. Apparently this specimen raises doubts as to the specific status of *erythrurus* in relation to *albolabris*.

According to the collector, this snake kills many cattle as it lies upon, rather than under, the rank herbage whose color it resembles.

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# THE SALTICID SPIDERS OF JAMAICA

BY ELIZABETH B. BRYANT

WITH THREE PLATES

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# No. 3.—*The Salticid Spiders of Jamaica*

By Elizabeth B. Bryant

Up to date there has been no comprehensive survey of the spider fauna of Jamaica. Prior to the year 1901, our knowledge of Jamaican spiders was largely limited to such descriptions as appeared from time to time in some general paper. In 1901, Dr. George W. Peckham and his wife Elizabeth G. Peckham, published in the Proceedings of the Zoological Society of London, a short paper entitled, "On the Family Attidae found in Jamaica." This was based on material collected by them while on a short visit to the island, a few years previously.

In this paper thirteen species were described as new, and brief mention is made of four others described earlier. Of the thirteen new species, two have proved to be synonyms, *Anoka moneagua* equals *Anoka peckhami* Cockerell, 1893, and *Pellenes banksi* is probably a poorly preserved specimen of *Habronattus coronatus* (Hentz), 1848, widely distributed in the southern United States and Cuba. The four species described earlier are, *Saitis annae* Cockerell, 1894, *Anoka peckhami* Cockerell, 1893, *Menemerus bivittatus* (Dufour), 1831, and *Zygoballus suavis* Peckham, 1895.

Since 1901, only one Attid from Jamaica has been described, *Prostheclina perplexiodes* Strand, 1908. Since this species, and *Saitis annae* Cockerell, were described from immature specimens, it seems improbable that either can ever be satisfactorily identified.

The Peckham Collection is now at the Museum of Comparative Zoölogy. The Jamaican material is dark and brittle from age, hence not easily examined for characters regarded as essential for generic determination; fortunately the excellent figures of Mr. J. H. Emerton, which illustrate the Peckham paper, have proved very helpful. From labels and casual references in the text, it can be inferred that the Peckhams collected at four localities, Kingston and San Antonio at sea level, and Moneague and Mandeville at approximately 2,000 feet.

Since the accession of the Peckham Collection, additional material has been received by the museum. Notable are the contributions of Dr. Thomas Barbour, late director of the museum, Mr. W. S. Brooks, Dr. C. T. Brues, Dr. H. L. Clark, and Miss Lilly Perkins. The most important addition has been from Dr. P. J. Darlington, Fall Curator of Coleoptera. On a short collecting trip in his special field to Jamaica, during the summer of 1934, he also included spiders. The material was especially welcome, since much of it is from the Blue Mountain Range and is all we have from the higher altitudes of the island.

The present paper identifies a total of twenty-six species, referred to sixteen genera. Six of the genera are described as new; these are *Allodecta, Anasaitis, Caribattus, Macotella, Paradecta,* and *Parasaitis.* Of the remainder, *Compsodecta* Simon, 1901, based on *Cybele grisea* Peckham, 1901, is probably confined to the West Indies, while *Avitis, Saitidops,* and *Wallaba* also occur in South America. The remaining six genera, *Habronattus, Hentzia, Lyssomanes, Metaphidippus, Thiodina,* and *Zygoballus* are widely distributed in the New World.

Of the twenty-six species, five are found on other islands of the West Indies; *Habronattus translatus* (Peck.), 1901, *Lyssomanes antillanus* Peck and Wheeler, 1888, *Menemerus bivittataus* (Dufour), 1831, and *Metaphidippus prudens* (Peck.), 1901, while *Thiodina cockerelli* (Peck.) 1901, may equal *Thiodina erucifer* (Cambr.), 1901, from Panama. As the descriptions of both are dated June, 1901, it may be difficult to decide which one has priority, if they do prove to be the same.

The remaining twenty species are known at present only from Jamaica. Nine of these, all from the Blue Mountain Range, are described as new.

Blue Mountain Peak, the highest point on Jamaica, is about 7,360 feet above sea level and Morne La Hotte, at the western end of Haiti, is 7,800 feet. If these portions of Hispaniola and Jamaica, as is supposed, have never been submerged during the many fluctuations of sea level, this might account for the fact that spiders from the higher altitudes of these two islands have not only retained primitive characters but have also developed modifications not found elsewhere. For example, in the family Salticidae, the usual number of ventral spines on the anterior metatarsi is two pairs. On Hispaniola, four genera, *Agobardus, Commoris, Dinattus,* and *Wallaba,* have three pairs; on Jamaica three genera possess this character, *Allodecta, Macotella,* and *Wallaba.* Among the many genera of Salticidae from Central America reported by F.O.P.-Cambridge in the "Biol. Centr.-Amer.," and by Dr. A. M. Chickering, in "The Salticidae of Panama," 1946, only one genus, *Cobanus* Cambr. 1901, has this unusual number.

Among the Araneae, the males of the Salticidae have perhaps, more secondary characters than are found in any other family. On those few islands where this family has been intensively studied, it would seem that on each island, certain genera have developed unusual modifications. Thus on Hispaniola the genus *Dinattus* has a large lateral projection on either side of the cephalic area, and as far as known, this modification is found nowhere else. On Jamaica, the maxillae have been modified in the genus *Paradecta.* Instead of the usual flat surface on the distal half, this portion is elevated in a cone, often ending with a chitinized tip or hook; the outline of this part is

almost circular, and in a few cases, the customary scopula is missing or very scant. In the genus *Compsodecta* Simon, the basal half of the maxillae is narrow and straight with parallel sides. In *Paradecta*, this basal half is narrow but arched outside the plane. Further investigation of the entire spider fauna of these islands along these lines is needed, and should yield interesting results.

This study is based on the material in the Museum of Comparative Zoölogy Collection. It is hoped that this paper may prove an incentive to intensive collecting over the entire island. Such an effort, covering all twelve months of the year, would certainly be rewarded by many additions in this one family.

May I take this opportunity to express my gratitude to all whose generous contributions have made this paper possible. Especially, I wish Mr. Nathan Banks to accept my appreciation of his unfailing interest and counsel.

The following key does not show relationships fully, as it selects only the more striking characters.

*Key to the male Salticidae recorded in this paper*

1. Eyes in four rows ..... *Lyssomanes*
   Eyes in three rows ..... 2
2. First metatarsus with three pairs of ventral spines ..... 3
   First metatarsus with two pairs of ventral spines ..... 5
3. First tibia with three pairs of ventral spines, no teeth on either margin of the fang groove, spinnerets very long, legs, 4–3–1–2 . . *Maeotella* gen. nov.
   First tibia with four pairs of ventral spines ..... 4
4. Mandibles with a diagonal carina, ending in a tooth above the base of the fang, lower margin of fang groove with one sharp tooth, legs, 4–1–3–2 *Allodecta* gen. nov.
   Mandibles not modified, upper margin of the fang groove with two small teeth, lower margin with a fissident tooth, legs, 1–3–4–2 . . . . . *Wallaba*
5. First and second tibiae with ventral bulbous hairs ..... *Thiodina*
   First and second tibiae with no bulbous hairs ..... 6
6. First tibia with ventral spines on the distal half ..... 7
   First tibia with ventral spines not confined to distal half ..... 9
7. Mandibles vertical, sides of cephalothorax vertical, first pair of legs slightly enlarged ..... *Metaphidippus*
   Mandibles porrect ..... 8
8. Mandibles very long, round, slightly divergent, upper margin of fang groove with a strong tooth near the base of the fang, lower margin with one small tooth, no thoracic groove ..... *Avitis*
   Mandibles flattened, divergent, upper margin of fang groove with two small widely separated teeth, lower margin with one large tooth, thoracic groove faint ..... *Hentzia*

9. Cephalothorax very high, quadrangle of eyes cover more than half cephalothorax ..... *Zygoballus*
   Cephalothorax very low and flat, quadrangle of eyes cover less than half the cephalothorax ..... *Menemerus*
   Cephalothorax of normal height, quadrangle covers less than half cephalothorax ..... 10
10. Fang groove with no teeth ..... 11
    Fang groove with teeth ..... 13
11. No ventral spines on first tibia ..... *Saitidops*
    Ventral spines on first tibia ..... 12
12. No lateral spines on anterior tibiae or metatarsi, patella and tibia of palpus flattened dorsally ..... *Parasaitis* gen. nov.
    Lateral spines on anterior tibiae and metatarsi, patella and tibia of palpus not flattened ..... *Anasaitis* gen. nov.
13. Third patella plus tibia longer than fourth patella plus tibia .. *Habronattus*
    Third patella not longer than fourth patella ..... 14
14. Mandibles large, flattened, with a forward projecting hook at base of the fang ..... 15
    Mandibles with no projecting hook at the base of the fang ..... 16
15. Maxillae with scopula, upper outer angle produced in a lobe or hook .... *Compsodecta*
    Maxillae sometimes with no scopula, distal half almost circular in outline and elevated in a cone ..... *Paradecta* gen. nov.
16. Mandibles broad, with a cusp on retrolateral margin, fang groove with two teeth on upper margin, and one bifid tooth on lower ..... *Caribattus* gen. nov.
    Mandibles rather narrow, with a U-shaped carina, a conical tooth on lower margin of groove ..... *Siloca*(?)

## Genus ALLODECTA gen. nov.

Cephalic portion high, sides parallel and vertical, thoracic groove short in a semi-circular depression between the dorsal eyes; *eyes*, anterior row recurved, small eyes about midway between the first and third rows; *quadrangle* slightly narrower behind than in front; *clypeus* less than a radius of a.m.e., with no scales; *mandibles* vertical, with a long diagonal carina ending in a tooth or hook near the base of the fang, lower margin of the fang groove with one sharp tooth; *labium* narrow, fully twice as long as wide; *maxillae* about one and a half times as long as labium, basal half rather narrow, rounded and arched from the plane, so that the distal half appears triangular; *legs*, 4–1–3–2, spines, I pair, tibia, ventral, 2–2–2–2, prolateral, 2, metatarsus, ventral, 2–2–2, no lateral, III and IV tibiae with a dorsal basal spine, IV metatarsus with a distal whorl of 4 spines; *palpus*, patella and tibia subequal, cymbium subequal with the tibia and narrower,

bulb confined to the cavity, tube S-shaped and embolus a spiral curve at the tip.

Genotype *Allodecta maxillaris* spec. nov.

The genus *Allodecta* differs from *Compsodecta* and *Pensacola* by the number of ventral spines on the tibia and metatarsus of the first pair of legs, the arched maxillae, and the very narrow cymbium. It differs from the genus *Commoris*, which also has three pairs of ventral spines on the anterior metatarsi, by the four pairs of ventral spines on the first tibia, the modified mandibles and the shape of the maxillae.

### Allodecta maxillaris spec. nov.

Figures 1, 3, 8

Male. Length, 5.6 mm., ceph. 2.8 mm. long, 2.1 mm. wide, abd. 3.0 mm. long, 1.8 mm. wide.

*Cephalothorax* brown, darker in the eye area, with a short narrow pale stripe from about the dorsal eyes, entire carapace with short iridescent hairs and a few orange-red hairs above the anterior eye row, cephalic portion high with many long hairs, sides parallel and vertical, posterior margin rounded, anterior margin truncate, thoracic groove short in a semi-circular depression between the dorsal eyes; *eyes*, anterior row recurved by the upper margins, eyes equidistant, a.m.e. large, separated by a little more than a line, a.l.e. less than a radius of a.m.e., eyes of the second row midway between the first and third rows, dorsal eyes larger than a.l.e. and not on the extreme margin, slightly raised and surrounded by black; *quadrangle* slightly narrower behind than in front; *clypeus* below a.m.e. less than a radius of a.m.e., with no scales or hairs; *mandibles* dark brown, vertical and long, with an oblique carina from about the middle, ending in a tooth above the base of the fang, the middle area depressed, fang groove rather short, slightly oblique, upper margin with a group of three small teeth at the median margin, lower margin with a single sharp tooth about the middle followed by a short carina to the base of the fang, fang as long as the groove with a thick base; *labium* pale, nearly twice as long as wide with rounded sides; *maxillae* pale, base very narrow and bowed out, distal half rounded and very broad, strongly convex and arched from the plane of the maxillae; *sternum* pale, oval, longer than wide, (3.5 : 2.5), pointed before the IV coxae; *abdomen* oval, dark gray, with a short median basal pale stripe, which is clouded with gray, two pale chevrons on the posterior half, venter pale, mottled with dark gray, dorsal spinnerets separated by a diameter to show the pale median pair, ventral spinnerets touching; *legs*, 4–1–3–2, I pair, femur

dark, other joints pale, II pair, pale, III and IV pairs pale with tibiae and metatarsi each with three dark rings, spines, anterior patellae with a prolateral spine, posterior patellae with prolateral and retrolateral spines, I pair, tibia, ventral, 2–2–2–2, prolateral, 2, metatarsus, ventral, 2–2–2, no lateral, II pair, tibia, ventral, 3p, 4r, prolateral, 1, retrolateral, 1, metatarsus, ventral, 2–2–2, no lateral, III and IV tibiae with a dorsal, basal spine, IV metatarsus, a distal whorl of 4 spines; *palpus* about as long as the cephalothorax, all joints white, except the cymbium and covered with long white hairs, patella and tibia subequal, tibial apophysis short and dark, cymbium brown, with darker hairs, little longer than the tibia and not as wide, bulb confined to the cavity, tube in an S-shaped curve, embolus a short curved spine at the tip.

Holotype ♂ Jamaica; Blue Mountains, Main Range, 5,000–7,000 feet, 17–19 August 1934, (Darlington). M.C.Z. No. B.0157

Paratype ♂ Jamaica; Blue Mountains, Main Range, 5,000–7,000 feet, 17–19 August 1934, (Darlington)

## Genus ANASAITIS gen. nov.

*Cephalothorax* high, sides only slightly rounded, thoracic groove short and faint in a depression between the dorsal eyes; *eyes*, anterior row recurved, small eyes about midway between the first and third rows; *quadrangle* slightly narrower behind than in front; *clypeus* narrow and covered with iridescent scales; *mandibles* short, vertical, with iridescent scales, fang groove very short, no teeth on either margin; *labium* about as long as wide; *maxillae*, basal half narrow, tips not modified, scopula scant; *sternum* only little longer than wide; dorsal spinnerets separated to show the median pair; *legs*, 3–4–1–2, or 4–3–1–2, I pair slightly enlarged, anterior pairs with iridescent scales, III patella plus tibia longer than corresponding joints of the IV pair, spines, I pair, tibia, ventral, 2–2–2, prolateral, 1, metatarsus, ventral, 2–2, lateral, 2–2, III and IV tibiae with a dorsal basal spine, III and IV metatarsi with distal and median whorls; *palpus*, about as long as cephalothorax, patella slightly longer than tibia, tibial apophysis short, bulb extending a little beyond the cavity, tube in an S-shaped curve in the bulb, embolus a short straight spine at the tip.

Genotype *Prostheclina morgani* Peckham.

The genus *Anasaitis* is separated from the genus *Saitis* by the iridescent scales on the clypeus and the mandibles of the male, the very short fang groove with no teeth on either margin, fang base very long. The dorsal spinnerets are separated to show the median pair,

and the anterior legs have iridescent scales with no brush on the third pair and but one prolateral spine on the anterior tibiae.

The species *Prostheclina morgani* was placed in the genus *Prostheclina* Keyserling by the Peckhams. This genus was established for a group of Australian spiders, now placed in the genus *Saitis*. *Saitis* has two small teeth on the upper margin of the fang groove and a large tooth on the lower margin. The genotype, *Saitis barbipes* Simon of Europe, has the third leg longest, with a thick brush of black hairs on the third metatarsus and no iridescent scales.

The genus *Anasaitis* is probably near the genus *Corythalia*. It differs, however, from that genus, by the smaller size, with but one prolateral spine on the anterior tibiae, but principally by the palpus. The genotype, *Corythalia latipes* Koch, from Brazil, has the first three pairs of legs heavily fringed with long black hairs, all spines large and heavy, two pairs of lateral spines on the anterior tibiae, and the embolus of the palpus in a large spiral at the tip of the bulb. Many species have been placed in the genus that do not belong there. Some have the first pair of legs the longest, others the third pair and some are lacking a fringe on any leg.

It is possible that *Corythalia locuples* (Simon), from Hispaniola, *C. signata* (Banks), and *C. gloriae* Petrunkevitch, from Puerto Rico, also belong to the genus *Anasaitis*, as all are rather small and have similar palpi.

### Anasaitis decoris spec. nov.

Figures 7, 9

Male. Length, 5.4 mm., ceph. 3.0 mm. long, 2.4 mm. wide, abd. 2.1 mm. long, 1.8 mm. wide.

*Cephalothorax* brown, ocular area black and covered with short white hairs, with a narrow band of iridescent scales posterior to the anterior eye row, a few scattered white hairs on the thoracic portion, cephalic portion high, a recurved depression between the dorsal eyes, with the thoracic groove in the depression, sides slightly rounded and vertical; *eyes*, anterior row recurved, a.m.e. large, separated by less than a radius, a.l.e. less than a radius of a.m.e. and separated from them by about a radius of a.l.e., second row of eyes about midway between the first and third rows, dorsal eyes convex and subequal with a.l.e.; quadrangle slightly narrower behind than in front; *clypeus* less than a radius of a.m.e., covered with iridescent scales; *mandibles* vertical, brown, covered with iridescent scales, fang groove very short, no teeth on either margin, fang with a heavy base; *labium* pale brown, only little longer than wide; *maxillae* pale brown, one and a half times

as long as the labium, not modified; *sternum* pale brown, only slightly longer than wide, (4.0 : 3.5), IV coxae almost touching; *abdomen* dark brown, with a pair of widely separated basal spots of iridescent scales, posterior half with vague pale chevrons, venter dark brown with a pair of curved pale lines from the fold to the spinnerets; *spinnerets*, dorsal pair separated to show the more slender median pair, ventral pair shorter than the others and touching; *legs*, 3–4–1–2, anterior pairs heaviest, pale brown, I pair with a prolateral and retrolateral brush of short dark hairs on tibia and metatarsus, II pair with a corresponding brush of shorter hairs, spines, I pair, patella, prolateral, 1, tibia, ventral, 2–2–2, all rather small, metatarsus, ventral, 2–2, lateral, 2–2, II pair same as the I pair, posterior pairs pale, more slender than the anterior pairs, with a basal dorsal tibial spine, metatarsi with distal and median whorls; *palpus*, about as long as cephalothorax, all joints with long dark hairs and dorsal iridescent scales, patella longer than the tibia, tibia about as long as the diameter of the joint, tibial apophysis small, a short triangular ventral lobe about the middle of the tibia, all parts difficult to see because of the many dark hairs, bulb not extending onto the tibia but prolonged in a rather short lobe outside the plane, tube in an S-shaped curve, embolus a short black spine at the tip.

Female. Length, 5.6 mm., ceph. 3.0 mm. long, 2.0 mm. wide, abd. 3.1 mm. long, 2.0 mm. wide.

*Cephalothorax* dark brown, ocular area black with no white hairs as in the male, cephalic portion high, a recurved depression between the dorsal eyes, sides parallel, vertical, thoracic groove in the depression; *eyes* as in the male; *clypeus* about as broad as a radius of a.m.e., no iridescent scales; *mandibles* brown with a few iridescent scales, fang groove the same as in the male; *labium*, *maxillae*, and *sternum* the same as in the male; *abdomen* brown, with a few iridescent scales at the base and sides, chevrons on the distal half more distinct than in the male; *legs*, 3–4–1–2, I left and II right missing, pale brown, with a few iridescent scales on the I patella and tibia, no brush of dark hairs on the anterior tibiae and metatarsi, spines, I pair, patella, prolateral, 1, tibia, ventral, 2–2–2, prolateral, 1, metatarsus, ventral, 2–2, lateral, 2–2, II pair the same as the first pair, III and IV pairs, tibiae with dorsal basal spine, metatarsi with distal and median whorls; *epigynum*, area about as long as wide, a pair of large sacs beneath the surface, separated by less than a radius, with a circular dark spot touching each sac at the anterior margin, and separated by about a diameter, slightly below are small hyaline spots; these spots may be the openings, and in the anterior portion a pair of narrow oblique spaces.

Holotype ♂ Jamaica; Blue Mountains, Main Range, 5,000–7,000 feet, 17–19 August 1934, (Darlington). M.C.Z. No. B.0158

Allotype ♀ Jamaica; Blue Mountains, Main Range, 5,000–7,000 feet, 17–19 August 1934, (Darlington)

Paratypes 4 ♂ 2 ♀ Jamaica; Blue Mountains, Main Range, 5,000–7,000 feet, 17–19 August 1934, (Darlington)

In the male the sides of the cephalothorax are slightly rounded, while in the female the sides are almost parallel. Peckham noted the same variation between the male and female in *Anasaitis venatoria* (*Prosthoclina*), from San Antonio, Jamaica. The other variations, such as the gray hairs on the ocular area, the iridescent scales on the clypeus, and the brush of black hairs on the anterior tibiae and metatarsi, of the male, are sexual characters that are not unusual in the Salticidae

### Anasaitis morgani (Peckham)

Figures 4, 6

*Prostheclina morgani* Peckham, 1901, p. 13, figs. 9–9d. "♂ ♀ Jamaica; Kingston." (6 specimens)

Male. Length, 3.5 mm., ceph. 1.6 mm. long, 1.5 mm. wide, abd. 2.0 mm. long.

*Cephalothorax* dark brown, with a wide transverse band of white scales posterior to the dorsal eyes, scattered white iridescent scales in the ocular area and a marginal stripe of white scales, cephalic portion high with a deep procurved groove between the dorsal eyes in which is the faint thoracic groove, convex posterior to the groove and then falling rapidly, sides vertical and slightly rounded, widest posterior to the eyes; *eyes*, anterior row recurved by the upper margins, a.m.e. separated by little more than a line, a.l.e. more than a radius of a.m.e. in diameter, and separated from a.m.e. by less than a radius of a.l.e., small eyes slightly nearer the dorsal eyes than to the first row, dorsal eyes not on the extreme margin of the carapace, subequal with a.l.e.; *quadrangle* slightly narrower behind than in front; *clypeus* retreating, below a.m.e., less than a radius of a.m.e.; *mandibles* brown, vertical, with iridescent scales on basal half, fang groove horizontal, very short, no teeth on either margin, fang with a thick base; *labium* pale brown, longer than wide; *maxillae* not twice as long as the labium, tips only slightly widened; *sternum* dark brown, flat, oval, two-thirds as wide as long, I coxae separated by more than a diameter, IV coxae touching; *abdomen* oval, dorsum flat, a broad median pale stripe and a narrow transverse band of white hairs just posterior to the middle,

divides the dorsum into four dark patches covered with black hairs, venter dark, spinnerets white, dorsal pair separated so that the dorsal and median pairs form a straight line, ventral pair directly below the median pair, the same length but heavier and dark; *legs*, 4–3–1–2, coxae pale with iridescent scales on the dorsal side, femora pale, I, II, and III tibiae dark, with a prolateral brush of short dark hairs, scattered iridescent scales on all joints, spines, anterior patellae, prolateral, 1, posterior patellae, lateral, 2, I pair, tibia, ventral, 2–2–2, prolateral, 1, metatarsus, ventral, 2–2, lateral, 2, II pair, patella and tibia subequal, spines, tibia, ventral, distal, 2, retrolateral, 1 at the base, metatarsus, ventral, 2–2, retrolateral, 1, III and IV tibiae with dorsal basal spine, metatarsi, distal and median whorls of spines; *palpus* about as long as the cephalothorax, femur and patella covered with white brilliant iridescent scales and long white hairs, patella longer than tibia, tibial apohysis not as long as the diameter of the joint, dark, with the inner margin serrate, cymbium brown, bulb extending slightly onto tibia in a truncate lobe, which rests on a spur of the tibia, tube S-shaped, embolus a short bent black spine at the tip.

Female. Length, 4.9 mm., ceph. 2.6 mm. long, 2.1 mm. wide, abd. 2.0 mm. long, 1.6 mm. wide.

*Cephalothorax* very dark with iridescent scales, cephalic portion high, sides slightly rounded, widest at the dorsal eyes, thoracic groove in a semi-circular depression between the dorsal eyes as in the male; *clypeus* almost wanting below a.m.e.; *mandibles*, brown, vertical, basal half covered with iridescent scales, fang groove horizontal, no teeth on either margin, fang short with a heavy base; *labium*, *maxillae*, and *sternum* as in the male; *abdomen* oval, dorsum flat, basal half dark, as the two basal spots are fused and are separated from the distal pair by an oblique bar, sides pale, many iridescent scales at the base, venter pale, with two short dark stripes, spinnerets long, all the same length, the dorsal pair separated, and with the median pair form a straight line, ventral pair heaviest; palpi pale with white iridescent hairs and scales on femur and patella; *legs*, 3–4–1–2, pale with no brush of dark hairs, spines, anterior patellae, prolateral, 1, posterior patellae, lateral, 2, III and IV tibiae, with a dorsal basal spine, I pair tibia, ventral, 2–2–2, no lateral, metatarsus, ventral, 2–2, lateral, 2, II pair, ventral, distal, 2, r1–1, metatarsus, ventral, 2–2, lateral, 2, III metatarsus, distal whorl, IV metatarsus, distal and median whorl of spines; *epigynum*, area as wide as long, two large ovals separated by a narrow septum, each side near the posterior end a large sac with a small dark spot at the anterior end, on the prolateral side of the dark spot a hyaline circular area which may be the openings, the middle area convex.

Co-types 6, Jamaica; Kingston, Peckham Coll. M.C.Z. No. B.0150
♂ ♀ Jamaica; Moneague, 26 August 1934, (Darlington)

The co-types are dark and fragile from age and are too brittle to handle, so the above description was written from the pair from Moneague, more recently collected. It is very difficult to count the spines on the tibiae of the male, as the joint is dark with many dark hairs and a prolateral brush of dark hairs covers the spines. The spinnerets are separated as in the genus *Maeotella*, but they are not quite as long when compared to the length of the abdomen. Probably, either from lack of lighting and small size or because the type lacks a moult of being adult, Emerton failed to see the convex area of the epigynum with the narrow septum and the hyaline spot on each of the dark sacs. His figures of the entire spiders, showing the four dark spots on the dorsum are excellent.

### Anasaitis scintilla spec. nov.

Figure 5

Male. Length, 5.1 mm., ceph. 2.6 mm. long, 2.2 mm. wide, abd. 2.2 mm. long, 1.5 mm. wide.

*Cephalothorax* dark, ocular area almost black, shining, cephalic portion high with tufts of dark hairs in the space between the eyes, sides slightly rounded, thoracic groove short in a depression slightly posterior to the dorsal eyes, thoracic slope convex; *eyes* cover about two-fifths of the carapace, anterior row recurved, a.m.e. separated by less than a radius, a.l.e. more than a radius of a.m.e., and separated from them by little more than the space between a.m.e., small eyes slightly nearer the first than the third row, dorsal eyes on the extreme margin of the carapace and subequal with a.l.e.; *quadrangle* slightly wider in front than behind; *clypeus* about as wide as the diameter of a.m.e., pale, covered with iridescent green scales; *mandibles* dark, vertical, rather short, anterior surface flat and covered with iridescent scales, fang groove horizontal, very short, no teeth on either margin, fang very short, base covers more than half the groove; *labium* pale brown, as long as wide; *maxillae* brown, about twice as long as the labium, basal half narrow, distal half widened but not developed in a lateral lobe; *sternum* brown, convex, nearly as wide as long, (2.0 : 2.4), fourth coxae almost touching; *abdomen* oval, dorsum flattened, basal half a dark brown, covered with iridescent scales, a pair of pale oblique bars about the middle that do not meet in the middle, posterior half with no scales, venter with a large pale rectangle surrounded by paler dots; *spinnerets*, dorsal pair long, and separated by more than

a diameter to show the slightly shorter slender median pair, ventral pair heaviest and touching; *legs*, 3–4–1–2, all femora pale, other joints of I and II pairs, dark with dark hairs, but no fringe, patellae and tibiae with iridescent scales, III and IV pairs pale, spines, I pair, patella, lateral, 2, tibia, ventral, 2–2–2, prolateral, 1, metatarsus, ventral, 2–2, prolateral, 2, II pair, same as the I pair but the spines are smaller, III and IV tibiae with a dorsal basal spine, III patella plus tibia longer than the corresponding joints of the IV pair, III and IV tibiae with a long median ventral spine, metatarsi with two whorls of spines; *palpus*, pale with the cymbium dark with iridescent scales, about as long as the cephalothorax, femur with a dorsal tuft of long soft white hairs at the tip, patella longer than the tibia, with a long trichobothria at the tip, tibia only slightly longer than the diameter of the joint, with a small dark ventral process, tibial apophysis a short dark spur parallel to the cymbium, bulb confined to the cavity, about half the length of the joint, tube S-shaped in the bulb with the embolus a very short bent black spine at the tip.

Holotype ♂ Jamaica; Blue Mountains, Main Range, south-west side, 3,000–4,000 feet, 13 August 1934, (Darlington). M.C.Z. No. B.0159.

*Anasaitis scintilla* differs from the genotype, *A. morgani* (Peckham), by the slightly larger size, the broad band of iridescent scales on the clypeus, the iridescent scales covering the mandibles, the few scales on the basal half of the abdomen and the simple tibial apophysis of the palpus.

### Anasaitis venatoria (Peckham)

Figure 10

*Prostheclina venatoria* Peckham, 1901, p. 13, figs. 10–10d. "♂ ♀ Jamaica, Port Antonio."

Male. Length, 3.5 mm., ceph. 2.0 mm. long, 1.2 mm. wide, abd. 1.6 mm. long, 1.1 mm. wide.

*Cephalothorax* dark brown, ocular area black, two converging lines of iridescent scales, starting at the a.l.e. and meeting midway between the thoracic groove and the posterior margin, a band of iridescent scales posterior to the anterior eye row, each side on the thoracic slope are patches of white hairs that probably represent the curved band of yellow hairs mentioned by the Peckhams, no marginal stripe of pale hairs, cephalic portion high, sides widened slightly posterior to the dorsal eyes, vertical, a recurved depression between the dorsal eyes in which is the short thoracic groove; *eyes*, anterior row recurved, a.m.e.

large and convex, separated by about a radius, a.l.e. little more than a radius of a.m.e. and separated from them by about a radius of a.l.e., small eyes slightly nearer the third row than the first row, p.l.e. subequal with a.l.e., convex and not on the extreme margin of the carapace; *quadrangle* slightly narrower behind than in front; *clypeus* brown, with a few scattered iridescent scales, about as wide as the diameter of a.m.e.; *mandibles* dark brown, vertical, no iridescent scales, fang groove short, no teeth on either margin; *labium* brown, longer than wide; *sternum* brown, nearly as wide as long; *abdomen* brown, with a median pale stripe, wider and more distinct on the distal half, with paired dark spots on the distal half that are almost broken chevrons, venter pale, spinnerets, dorsal pair pale, widely separated to show the more slender median pair, ventral pair dark, almost touching and much stouter; *legs*, 3–4–1–2, IV left missing, brown, tarsi pale, scattered iridescent scales on the posterior patellae, anterior tibiae darker from the dark hairs, spines, I pair, patella, prolateral, 1, tibia, ventral, 2–2–2, prolateral, 1, metatarsus, ventral, 2–2, lateral, 2–2, posterior pairs with dorsal basal spine on tibiae; *palpus* about as long as the cephalothorax, femur pale, with a dorsal tuft at the tip of long white hairs, patella longer than tibia, both joints with iridescent scales, tibial apophysis short, bulb barely reaching the tibia, tube in an S-shaped curve, embolus a short bent spine at the tip.

Lectotype ♂ Jamaica; Port Antonio, Peckham Coll. M.C.Z. No. B.0152.

2 ♂ Jamaica; St. Ann's Castle, Daly, 25 August 1934, (Darlington).

2 ♂ Jamaica; Blue Mountains, Main Range, 5,000–7,000 feet, 17–19 August 1934, (Darlington).

Peckham described a male and a female from Port Antonio, but the female is now missing and the male is dark and brittle. The above description is from a male collected at St. Ann's Castle, Daly, by Dr. Darlington. The specimen has recently moulted and the iridescent scales are in place. The converging lines of scales that form a deep V on the cephalothorax are very conspicuous, as well as the scales on the palpus.

## Genus AVITIS Peckham 1896

### AVITIS TAYLORI (Peckham)

*Dendryphantes taylori* Peckham, 1901, p. 14, figs. 12–12b. "♂" [Jamaica].

Male. Length, 4.5 mm., ceph. 2.1 mm. long, 1.8 mm. wide, abd. 2.5 mm. long, 1.3 mm. wide, mand. 1.3 mm. long.

*Cephalothorax* brown, with a few scattered scales, and a patch of

white hairs below the a.l.e., cephalic portion very high, sides rounded, not vertical, widest posterior to the dorsal eyes, convex, a slight recurved depression between the dorsal eyes, thoracic groove very faint in this depression; *eyes*, anterior row recurved, a.m.e. large and convex, separated by a little more than a line, a.l.e. about half the diameter of a.m.e. and separated from them by a little more than the space between a.m.e., small eyes plainly nearer the first than the third row of eyes, dorsal eyes not on the margin of the carapace and slightly smaller than a.l.e.; *quadrangle* wider behind than in front; *clypeus* little wider than a radius of a.m.e., with a band of white hairs; *mandibles* brown, porrect and slightly divergent, basal joint 1.3 mm. long, round, fang groove oblique, upper margin with a strong tooth near the base of the fang, lower margin with a smaller tooth near the base, fang as long as the groove, slender and sinuous; *labium* brown, longer than wide; *maxillae* brown, almost twice as long as the labium, parallel, tips not modified; *sternum* brown, longer than wide, I coxae long and heavy, separated by about a diameter, trochanter not as long as the diameter of the joint, IV coxae almost touching; *abdomen* brown, probably with a broad median paler stripe, a very narrow lateral stripe of white hairs on the basal half, scarcely visible on the dorsal side, and two pairs of short transverse bars of white hairs on the posterior half, venter paler, spinnerets, dorsal pair separated to show the shorter median pair, ventral pair touching and about as long as the median pair; *legs*, 1–4–2–3, much broken, brown, tarsi pale, I pair much the longest, spines, I pair, patella, 0, tibia, ventral, 2–2–2, not opposite, prolateral row confined to the distal half, retrolateral row on the distal two-thirds, metatarsus, ventral, 2–2, II pair, patella, 0, tibia, ventral, 2–2–1, the third spine on the prolateral row missing, metatarsus, ventral, 2–2, III and IV pairs much broken but a few ventral spines at the tip of tibiae; *palpus*, pale brown, slender, femur curved, patella little longer than the tibia, cymbium about as long as patella plus tibia, tibial apophysis not as long as the diameter of the joint, bulb confined to the basal two-thirds of the cymbium, not extending onto the tibia, embolus a long slender slightly curved black spine starting from the upper outer angle of the bulb and ending at the tip.

Holotype ♂ [Jamaica] Peckham Coll. M.C.Z. No. B.0154.

This species was described as a *Dendryphantes*. Today, this genus is confined to Europe and all the small species described by the Peckhams in that genus have been placed in the genus *Metaphidippus* F.O.P.-Cambridge, 1901. The genotype of *Metaphidippus* is *mandibulatus* F.O.P.-Cambr. from Costa Rica. This species also, has the long porrect mandibles but the sides of the cephalothorax are almost parallel and are vertical. The palpus is quite a different type.

The genus *Avitis* was based by the Peckhams on the species *diolenii* from New Grenada, (Panama), given them by the Keyserlings. This vague locality may mean any place from the low coastal area, to the mountains. The type is now before me, and while it is a little larger, (7.0 mm. long,) than *A. taylori*, the two agree in the principal structural characters, such as the position of the eyes, labium, maxillae, the very long first pair of legs, with the same arrangement of spines, and the color pattern on the abdomen. The palpi are of the same type. It does differ in the number of teeth on the lower margin of the fang groove. *A. diolenii* has two small teeth on the lower margin of the fang groove, where *A. taylori* has but one, and the third pair of legs is longer than the second pair in *diolenii*. This latter character is hard to compare as the legs of *A. taylori* are much broken, and the relative length of the legs has been taken from the original description.

Simon has added to the genus another species from the Argentine, but the description is based principally on color, rather than structure. In the description of the genus in the Histoire Naturelle des Araignées, Simon has added several characters that do not agree with either *diolenii* or *taylori*, so the Argentine species possibly does not belong to the genus *Avitus*.

## Genus CARIBATTUS gen. nov.

Cephalic portion high, sides vertical and almost parallel, thoracic groove in a slight depression between the dorsal eyes; *eyes* anterior row strongly recurved, a.m.e. very large, eyes of the second row midway between the first and third rows, dorsal eyes on the margin of the carapace; *quadrangle* slightly narrower behind; *clypeus* less than a radius of a.m.e.; *mandibles* in the male, broad, vertical, a tooth or cusp on the retrolateral margin, fang groove with two teeth on the upper margin, lower margin with a bifid tooth; *labium* as long as wide; *maxillae* not modified; *legs*, 4–3–1–2, spines, I pair, ventral, 2–2–2, no lateral, metatarsus, ventral, 2–2, basal pair very long, IV metatarsus with two whorls of spines; *palpus*, with tibia longer than patella, bulb with an S-shaped tube, confined to the cavity, embolus curved at the tip.

Genotype *Saitis inutilis* Peckham.

The genus *Caribattus* is separated from the genus *Saitis*, by the bifid tooth on the lower margin of the fang groove, the relative length of the legs, and the type of palpus.

The genus *Saitis* was based by Simon on the species *barbipes* Simon, a common spider in France and England. The mandibles are rather narrow and vertical, with a conical tooth on the lower margin of the

fang groove. The third pair of legs are plainly the longest and the metatarsus of that pair is covered with a brush of hairs; in the palpus, the bulb extends in a narrow lobe the length of the tibia and the embolus is long and only slightly curved. Simon referred two species from Venezuela to the genus, where the fourth pair of legs is longer than the third, but the descriptions show no other structural character.

### Caribattus inutilis (Peckham)

*Saitis* ? *inutilis* Peckham, 1901, p. 10, figs. 4–4b. "♂" [Jamaica].

Male. Length, 3.5 mm., ceph. 2.0 mm. long, 1.5 mm. wide, abd. 2.0 mm. long, 1.5 mm. wide.

*Cephalothorax* brown, ocular area paler, with a pale median stripe from the thoracic groove to the posterior margin, a pale marginal stripe of white hairs connects with the white hairs on the clypeus below the a.l.e. and p.m.e., cephalic portion high, rising gradually from the anterior eye row to the dorsal eyes where it falls gradually at first and then rapidly to the posterior margin, sides vertical, and almost parallel, thoracic groove very short in a slight depression between the dorsal eyes; *eyes*, anterior row strongly recurved, a.m.e. very large, separated by more than a line, a.l.e. less than a radius of a.m.e. and separated from them by about twice the space between the a.m.e., a row of orange-red hairs about the eyes of the anterior row, second row of eyes midway between the first and third rows, dorsal eyes slightly larger than a.l.e. and on the extreme margin of the carapace; *quadrangle* slightly narrower behind than in front; *clypeus* below a.m.e. about a radius of a.m.e., covered with white hairs and projecting slightly; *mandibles* dark brown, vertical, a small cusp above the base of the fang on the exterior margin, fang groove almost horizontal, upper margin with two teeth, lower margin with a bifid cusp; *labium* dark brown, as long as wide, with the tip rebordered; *maxillae* not twice as long as the labium, sides parallel, tips not modified; *sternum* pale, shining, oval, four-fifths as wide as long, first coxae separated by more than a diameter, fourth coxae almost touching; *abdomen* oval, brown, with a pale irregular median stripe, and three chevrons on the posterior half, sides dark, venter pale, dorsal spinnerets separated and with the median pair form a straight line, ventral pair the same length, heavier and separated by about half a diameter; *legs*, 4–3–1–2, much broken, I pair, femur slightly enlarged, anterior pairs darker, all with broken dark rings on the tibiae and metatarsi, spines, I pair, tibia, ventral, 2–2–2, metatarsus, ventral, 2–2, basal pair very long, IV metatarsus with two whorls of 4 spines; palpus, left palpus missing, brown,

about as long as the cephalothorax, tibia longer than the patella, with scant lateral fringes, tibial apophysis as long as the diameter of the joint, bulb confined to the basal two-thirds of the cymbium, not extending onto the tibia, with an S-shaped tube, embolus a curved spine at the tip.

Lectotype ♂ Jamaica, Peckham Coll. M.C.Z. No. B.0147.

Co-type ♂ Jamaica, Peckham Coll.

## Genus COMPSODECTA Simon 1902

*Cephalothorax* with cephalic portion high, sides rounded, a semicircular depression between the dorsal eyes with a short thoracic groove; *eyes*, anterior row recurved, so that the upper margins form a straight line, small eyes midway between the first and third rows; *quadrangle* slightly narrower behind than in front; in the males, the mandibles vertical, widest about the middle, with a retrolateral or oblique carina ending in a tooth above the base of the fang that is directed forward, anterior surface either granular or striate, fang groove with two teeth on the upper margin and one tooth on the lower margin; *labium* longer than wide, with tip rebordered; *maxillae*, basal half narrow, sides parallel, distal half widened on the retrolateral side in a lobe opposite the scopula; *palpus* with patella longer than tibia, both joints flattened, patella narrower at the femoral end and much widened at the tibial end, with lateral carinas, and a distal lobe that extends over the tibia, tibia with a lateral carina, cymbium about as long as the tibia, bulb confined to the cavity, and the embolus a spiral coil at the tip.

Genotype *Cybele grisea* Peckham.

The genus *Compsodecta* was based by Simon on two species collected by the Peckhams in Jamaica. Peckham evidently sent him a specimen of *Cybele grisea*, as he made that species the genotype, and noted in the generic description several characters not mentioned by the authors in the original description of the species. *Cybele albopalpis*, the second species, was described from an unique specimen, and belongs to another genus, as it differs in the number of teeth on the fang groove, and the number of spines on the anterior legs. Incidentally, the name *Cybele* had been used previously by Loven in 1845, and again by Reichenbach in 1852.

Simon separated the genus *Compsodecta* from *Pensocola* Peckham, 1885, found in Central America and Brazil, by the number of spines on the distal whorl of spines on the fourth metatarsus and on the secondary characters in the male. Another species of *Compsodecta* has

been added to the genus from the foot hills of Massif de la Hotte, Haiti, at an altitude of 3,000–4,000 feet, and the species *Saitis defloccata* Peckham from Jamaica, based on a female has been transferred to the genus, as the epigynum is of the same type, and the spines on the legs and the teeth on the fang groove are the same as in the genotype.

It is doubtful if the genus is found beyond the islands of the Caribbean. Simon suggests that *Sidusa maxillosa* F.O.P.-Cambr. from Guatemala may belong here. This species is unknown to me. According to the description and the figures, the patella and tibia of the palpus are flattened, but no mention is made of the shape of maxillae, the tooth on the mandibles or the number of spines on the distal whorl of the fourth metatarsus, three characters that Simon stressed in the description of the genus.

### Compsodecta defloccata (Peckham)

Figure 2

*Saitis defloccatus* Peckham, 1901, p. 11, figs. 5–5a. "♀ Jamaica; Kingston."

Female. Length, 4.5 mm., ceph. 1.7 mm. long, 1.4 mm. wide, abd. 2.4 mm. long.

*Cephalothorax* brown, with a pale spot in the ocular area, and a faint median pale stripe from the thoracic groove to the posterior margin, thinly covered with small golden iridescent scales, cephalic portion very high, level, and sloping gradually from the groove to the posterior margin, first gradually and then abruptly, sides parallel and vertical, posterior margin less than half the anterior, thoracic groove slightly posterior to the dorsal eyes, short and in a semi-circular depression; *eyes*, anterior row recurved, upper margins form a straight line, a.m.e. large and touching, a.l.e. about half the diameter of a.m.e., and separated from them by a radius of a.l.e., second row of eyes nearer the first than the third row, dorsal eyes on the extreme margin and larger than a.l.e.; *quadrangle* wider behind than in front; *clypeus* almost wanting below a.m.e. and retreating; *mandibles* brown, vertical, not modified, fang groove short, horizontal, upper margin with two contiguous teeth, lower margin with a large sharp tooth; *labium* brown, longer than wide with a rebordered tip; *maxillae* paler than labium, sides parallel, about one and a half times as long as labium; *sternum* brown, oval, two-thirds as wide as long, (3.5 : 5.0), convex, first coxae separated by more than a diameter, fourth coxae separated by a radius; *abodmen* oval, a dull brown, with a pair of irregular dark stripes on the basal half, followed by a dark chevron about the middle and vague

lateral dark marks, venter with a large dark triangle from the fold to the spinnerets, sides dark, spinnerets long, dorsal pair separated so that the slender median pair are seen, ventral pair stout and touching, same length as the median pair; *legs*, 4–3–1–2, femora dark, other joints pale with broken dark rings, first pair slightly enlarged, spines, all patellae with lateral spines, I pair, tibia, ventral, 2–2–2, prolateral, 2, retrolateral, 1, metatarsus, ventral, 2–2, lateral, 2–2, ventral spines long, first basal prolateral as long as the joint, II pair the same as the first pair but spines are smaller, III and IV pairs, with a dorsal basal spine on tibiae, III tibia, ventral, median, 1–1, IV tibia, ventral, median, 1–1, very long, III and IV metatarsi, a distal whorl of 4 spines; *epigynum*, area about as wide as long, a median septum divides the area into two large ovals with a circular hyaline area near the posterior margin, the retrolateral margins of the ovals deeply edentate, these may be the openings as they are quite distinct.

Holotype ♀ Jamaica, Kingston, Peckham Coll. M.C.Z. No. B.0148.

The species *defloccatus* does not belong in the genus *Saitis*, as the quadrangle of eyes is wider behind than in front, there are lateral spines on the anterior tibiae, and the fourth pair of legs is longer than the third pair. Unfortunately, the original figure of the epigynum does not show the large lateral openings that are quite distinct. It is somewhat smaller than the genotype, but it has the same type of epigynum, and the quadrangle of eyes is slightly wider behind than in front.

### Compsodecta grisea (Peckham)

Figures 11, 12, 13, 14, 15

*Cybele grisea* Peckham, 1901, p. 8, figs. 2–2e. "♂s ♀s" [Jamaica].

Male. Length, 5.0 mm., ceph. 2.2 mm. long, 2.0 mm. wide, abd. 2.0 mm. long.

*Cephalothorax* much discolored and faded from age, so that it is impossible to trace either color, markings or hairs; according to the original description, the entire cephalothorax is covered with red hairs, and has a lateral stripe of white hairs and a median stripe of white hairs on the thoracic slope; cephalic portion very high, widest posterior to the dorsal eyes, sides rounded, a semi-circular depression between the dorsal eyes with a short thoracic groove, thoracic slope first falls gradually and then abruptly to the posterior margin, posterior margin less than half the anterior margin; *eyes* cover the anterior margin, anterior row recurved, so that the upper margins of the eyes form a straight line, eyes equidistant, a.m.e. large, separated by less than a

radius, a.l.e. about a radius of a.m.e., eyes of second row about midway between the first and third rows, dorsal eyes about on the margin of the carapace, and subequal with a.l.e.; *quadrangle* slightly narrower behind than in front; *clypeus* about wanting below a.m.e.; *mandibles* brown, vertical, broad, anterior surface flat and striate, distinct prolateral carina, widest about the middle, with a cusp or wing, a sharp tooth above the base of the fang directed outward from the plane of the mandible, fang groove slightly oblique, rather short, lower margin with one large tooth, fang with a heavy base; *labium* brown, longer than wide; *maxillae* pale, more than twice as long as labium, basal half very narrow, and sides parallel, distal half widened and outer upper angle produced in a sharp point, inner margin with a brush of long hairs; *sternum* brown, oval, about half as wide as long, first coxae separated by a diameter, fourth coxae separated by less than a diameter; *abdomen* much shrunken and discolored by age, spinnerets long, dorsal pair widely separated; *legs*, 1–3–4–2, discolored and fragil, I tibia with a ventral fringe of long white hairs, spines, patellae, lateral, 2, III and IV tibiae with dorsal basal spine, I pair, tibia, ventral, 2–2–2, middle pair not opposite, lateral, 2–2, metatarsus, ventral, 2–2, those of prolateral row from a raised base, lateral, 2–2, all spines heavy, II pair, the same as I pair, but spines not as large, III and IV metatarsi with a distal whorl of 5 spines, one dorsal; *palpus*, longer than cephalothorax, femur and patella of equal length, femur with a dorsal crest of short hair and two stout spines at the tip with a larger posterior spine, patella narrow at the femoral end, flattened dorsally, with a carina on each lateral margin, the prolateral carina ending in a triangular lobe that projects upward and forward, beneath the lobe a long colorless bristle from a chitinized base, parallel and almost as long as the tibia, tibia two-thirds as long as the patella, flattened dorsally, with a carina on each side, widest about the middle, with a ventral fringe of long white hairs, tibial apophysis triangular, and not as long as the diameter of the joint, cymbium about as long as the tibia, covered with short hairs, bulb confined to the cavity and embolus in a spiral curve at the tip.

Female. Length, 6.0 mm., ceph. 2.5 mm. long, 2.0 mm. wide, abd. 3.0 mm. long.

*Cephalothorax* and *eyes* as in the male; *mandibles* brown, vertical, not modified, fang groove short, lower margin with one tooth, fang with a thick base; *labium* as in the male; *maxillae* twice as long as the labium, tips enlarged but not pointed; *abdomen* pale, with a wavering dark marks, heaviest on the posterior half, venter pale, with a dark patch over the posterior spiracle which is covered by a small lobe, (?), spinnerets long, dorsal pair separated by a diameter, showing the

median pair between; *legs*, 1–4–2–3, spines as in the male; *epigynum*, two clear ovals spaces beneath the surface, a little more than a line above the fold, separated by a narrow septum, at the posterior portion, a pair of large circular sacs, touching on the median margins, and a smaller pair just anterior and more widely separated, the openings are probably small oval slits just anterior to the smaller pair of sacs.

Lectotype ♂ Jamaica. Peckham Coll. M.C.Z. No. B.0145.

Lectotype ♀ Jamaica. Peckham Coll.

The type vial contains three males and several females, all faded and discolored from age. All three males have the abdomens so shrunken that it is impossible to see if the opening of the posterior spiracle is covered by a lobe as in the female. The above description is from a pair of the co-types that have been selected as lectotypes.

Unfortunately, the original figure of the epigynum, plate II, fig. 2e, is inverted. The two pairs of dark sacs are in the posterior portion, just above the fold.

## Genus HABRONATTUS F.O.P.-Cambridge 1901

### HABRONATTUS CORONATUS (Hentz)

*Attus coronatus* Hentz, 1846, p. 361, pl. 22, fig. 1; reprint, 1875, p. 64, pl. 9, fig. 1. "♂ Alabama, May–June."
*Pellenes banksi* Peckham, (?), 1901, p. 12, pl. 3, figs. 7–7a. "♀ Kingston."
*Habronattus coecatus* F.O.P.-Cambridge, 1901, p. 246, nec Hentz.
*Pellenes coronatus*, Peckham, 1909, p. 545, pl. 45, figs. 3–3d.

A male collected by Dr. Darlington has recently moulted, and every hair and scale is in place. Compared to the specimens in the collection from the south and west of the United States, the only difference noted is two short lines of white hairs between the posterior lateral and posterior median eyes. As far as known, no mention of these white lines has been made before, but in a smaller specimen in the collection from St. Simon's Island, Georgia, collected April 20, 1930, in the Emerton Coll., there are three lines of white hairs in the same place. The Kingston specimen has the same ornamentation on the third femur and patella, and the same palpus. It is not impossible, that *Pellenes banksi* Peckham, is the female of *H. coronatus* in the penultimate moult. *H. coronatus* has been found in several localities in Cuba.

♂ Jamaica; Kingston, 27–29 August 1934, (Darlington).

### Habronattus translatus (Peckham)

*Pellenes translatus* Peckham, 1901, p. 11, figs. 6–6a. "♂ Jamaica; Mandeville, (Cockerell), Peckham Coll.

*Pellenes facetus* Petrunkevitch, 1930, p. 181, figs. 163, 164. "♀ Porto Rico; Rio Piedras, September 26, 1925."

Both males and females have been found at Havana and Soledad, Cuba, and on Mona Island. Unfortunately, the type is missing, and no specimen from Jamaica has been seen.

## Genus Hentzia Marx 1883

### Hentzia peckhami (Cockerell)

*Anoka peckhamii* Cockerell, 1893, p. 624. "Jamaica; Kingston."

*Anoka moneagua* Peckham, 1894, p. 127, pl. 12, figs. 9–9a. "♂ ♀ Jamaica; Moneague."

Male. Length, 4.1 mm., ceph. 2.0 mm. long, 1.5 mm. wide, abd. 2.4 mm. long, 1.0 mm. wide.

*Cephalothorax* brown, with a wide lateral stripe of white hairs, a very narrow pale stripe from the groove to the posterior margin, eyes surrounded by black, cephalothorax rather low and flat, sides rounded, thoracic groove very short in a circular depression slightly posterior to the dorsal eyes; *eyes*, anterior row recurved by the upper margins, a.m.e. separated by more than a line, a.l.e. about a radius of a.m.e., and separated from them by almost a radius of a.m.e., second row of eyes slightly nearer the first than to the third row, dorsal eyes not on the extreme margin of the carapace, and slightly larger than a.l.e.; *quadrangle* about as wide behind as in front; *clypeus* almost wanting below a.m.e.; *mandibles* brown, porrect, and slightly divergent, wide at the base and narrowed to the width of the fang at the tip, flat, with a distinct carina on each margin, the retrolateral margin with a fringe of graduated white hairs, fang groove oblique, upper margin with two rather small widely separated teeth, lower margin with one large tooth midway between the two teeth on the opposite margin, fang long and sinuous; *labium* brown, longer than wide, tip rebordered; *maxillae* not quite twice the length of the labium, with the upper outer angle produced in a sharp lobe; *sternum* pale, oval, longer than wide, (5.0 : 3.5), I coxae separated by less than a diameter, IV coxae almost touching; *abdomen* long and narrow, much wider at the base than at the spinnerets, pale, with vague darker marks, the most conspicuous a narrow transverse bar a little anterior to the spinnerets, venter pale;

*legs*, 1–4–2–3, I pair dark brown, other pairs pale, I pair enlarged, femur flattened laterally, with a short ventral retrolateral row of hairs near the tip, followed on the patella by similar hairs, spines, from a raised base, patella, 0, tibia, ventral, 2–2–2, not opposite, metatarsus, ventral, 2–2, II pair, patella, 0, tibia, ventral, 2 distal, followed by 1–1 retrolateral, metatarsus, ventral, 2–2, III and IV pairs, patellae, 0, tibiae, ventral, 2 distal; *palpus*, brown, about as long as the cephalothorax, femur bent, patella longer than the tibia, tibial apophysis shorter than the diameter of the joint, cymbium flattened dorsally at the tip, bulb extending onto the tibia, embolus a transverse spine across the tip.

Female. Length, 4.1 mm., ceph. 2.1 mm. long, 1.8 mm. wide, abd. 2.4 mm. long, 1.5 mm. wide.

*Cephalothorax* the same as in the male, except for the pair of dark spots in the eye area, and a little greater width in proportion to the length; *eyes* same as in the male; *clypeus* almost wanting below a.m.e., with a fringe of white hairs on the margin; *mandibles* brown, vertical, flat, fang groove transverse, upper margin with two small teeth close together, lower margin with a large plate opposite the teeth on the upper margin, fang rather short; *labium*, dark brown, longer than wide; *maxillae* not twice as long as the labium, tips rounded; *sternum* brown, convex, almost as wide as long, (4.0 : 4.3); *abdomen* pale with reddish-brown markings, a pair of elongate basal spots, followed by two large dark spots, the last meeting the narrow transverse bar, sides with small dark lines, venter pale; *legs*, 1–4–2–3, I pair light brown, tarsi pale, other pairs pale, I pair enlarged, the retrolateral row of spindle-shaped hairs at the tip of the femur and the patella, spines the same as in the male; *palpi* pale with a dark ring at the tip of the femur, patella, and tibia; *epigynum*, characteristic of the gemus, with oblique widely separated openings on the anterior portion, followed by a pair of convolute tubes.

♂ ♀ Jamaica; Mandeville, 13 April 1937, (Roys).

♂ Jamaica; Mandeville, March 1934, (Bryant).

♂ Jamaica; (Perkins).

There is evidently variation in the development of the mandibles in the male and the relative position of the large tooth on the lower margin of the fang groove. Where the mandibles are large and elongate, the tooth is much larger and nearer the base than in the specimens with the shorter mandibles.

The female described above probably lacks one moult of maturity, as the group of three stout bristles posterior to the anterior lateral eyes is lacking. These do not develop until the last moult. Although Cockerell does not state the sex in the original description of *Anoka*

*peckhami,* he evidently had an adult female, as he notes this cluster of three curved bristles posterior to the anterior lateral eyes and the dark rings at the tips of the joints of the palpi.

## Genus LYSSOMANES Hentz 1844

### LYSSOMANES ANTILLANUS Peckham and Wheeler

*Lyssomanes antillanus* Peckham and Wheeler, 1888, p. 226, pl. 11, fig. 1. "♂ San Domingo, Simon Coll."

This species has been found on several islands of the Caribbean. It is common in Cuba, Hispaniola, and Puerto Rico. Two immature specimens have been seen from Jamaica, which tentively have been placed in this species.

♀ pullus Jamaica; Blue Mountains, Main Range, south-west side, 3,000–4,000 feet, 13 August 1934, (Darlington).

pullus Jamaica; Surrey, Bath, 300 feet, 1 April 1937, (Roys).

## Genus MAEOTELLA gen. nov.

*Cephalothorax* high, thoracic groove short and faint; *eyes,* anterior row recurved by the upper margins, second row nearer the dorsal eyes than to the anterior row; *quadrangle* narrower behind than in front; *clypeus* more than a radius of a.m.e. and in the male with a fringe of long iridescent hairs on the margin; *mandibles* small and vertical, not modified, fang groove very short, no teeth on either margin in the male, and one small tooth on the lower margin in the female; *labium* longer than wide; *maxillae* not modified; *abdomen* and the anterior pairs of legs in both sexes, with iridescent scales or hairs; *spinnerets* very long, dorsal pair separated to show the slender median pair, ventral and median pairs the same length; *legs,* 4–3–1–2, anterior tibiae with 2–2–2 ventral spines, no lateral, metatarsi with 2–2–2 ventral spines, no lateral, posterior metatarsi with a distal and median whorl of spines.

Genotype *Protheclina perplexa* Peckham.

The genus *Maeotella* is separated from the genus *Saitis* by the very long spinnerets, the three pairs of spines on the anterior metatarsi and the second row of eyes nearer the dorsal eyes than to the anterior row. It is separated from the genus *Oningis* by the spines on the legs and the long spinnerets, and from the genus *Maeota* by the position of the second row of eyes and the spines on the legs.

### Maeotella perplexa (Peckham)

*Prostheclina perplexa* Peckham, 1901, p. 12, figs. 8–8d. "♂ ♀ Jamaica; Mandeville."

Male. Length, 4.5 mm., ceph. 2.5 mm. long, 1.6 mm. wide, abd. 2.1 mm. long.

*Cephalothorax* darker about the eyes, a row of brilliant iridescent scales below the lateral eyes and scattered iridescent scales on the ocular area, cephalothorax moderately high, sides slightly rounded, widest posterior to the dorsal eyes, a recurved depression posterior to the dorsal eyes containing the short and faint thoracic groove, thoracic slope first gradual and the abrupt; *eyes* seen from the front, anterior row recurved by the upper margins, a.m.e. separated by less than a radius, a.l.e. more than a radius of a.m.e. and separated from them by a radius of a.l.e., eyes of the second row nearer the dorsal eyes than to the anterior row, dorsal eyes not on the extreme margin of the carapace and smaller than the a.l.e.; *quadrangle* narrower behind than in front; *clypeus* almost a diameter of a.m.e. with a thin fringe of iridescent hairs on the margin; *mandibles* vertical, brown, basal half with many iridescent hairs and scales, fang groove very short, no teeth on either margin, fang with a very thick base; *labium* pale brown, longer than wide, tip pointed; *maxillae* pale brown, almost twice as long as the labium, tips only slightly enlarged; *sternum* brown, two-thirds as wide as long, convex, I coxae separated by more than a diameter, IV coxae almost touching; *abdomen* oval, with long white-iridescent hairs at the base and with broken dark chevrons on the posterior half, sides a dull brown, venter with three faint dark stripes, spinnerets very long, about one-quarter as long as the abdomen, the dorsal pair separated by more than a diameter, showing the shorter median pair, ventral pair as long as the median pair and heavier; *legs*, 4–3–1–2, brown, femora darker, anterior pairs with iridescent scales, I pair slightly enlarged, spines, anterior patellae, prolateral, 1, III and IV tibiae with a dorsal basal spine, III and IV metatarsi with a distal and median whorl of spines, I pair, tibia, ventral, 2–2–2, distal and median on prolateral row very long, other spines small and weak, lateral, 0, metatarsus, ventral, 2–2–2, basal and median long, II pair, tibia, ventral, 2–2–2, all small, metatarsus, ventral, 2–2–2, much smaller than on I pair, IV metatarsus longer than IV tibia; *palpus*, about as long as the cephalothorax, brown, femur with a large dorsal tuft of long white hairs at the tip, patella slender and almost twice as long as the tibia, cymbium about as long as the patella plus tibia, tibia and cymbium with iridescent hairs, tibial apophysis shorter than the diameter of the joint, bulb confined to the cavity and less than

half the length of the cymbium, tube with an S-shaped curve, embolus a straight black point at the tip of the bulb.

Female. Length, 5.1 mm., ceph. 2.3 mm. long, 1.7 mm. wide, abd. 2.6 mm. long. 2.0 mm. wide.

*Cephalothorax* much darker than in the male, ocular area almost black with small scattered iridescent hairs, thoracic groove in a semicircular depression between the dorsal eyes; *eyes* same as in the male; *clypeus* about a radius of a.m.e., with no fringe of iridescent hairs on the margin as in the male; *mandibles* dark brown, vertical, fang groove very short, horizontal, lower margin with one small tooth, fang short with a heavy base; *labium* brown, longer than wide; *maxillae* not twice as long as the labium, tips very little enlarged; *sternum* brown, convex, more than two-thirds as wide as long, I coxae separated by more than a diameter, IV coxae separated by less than a diameter; *abdomen* oval, brown, with an indistinct darker pattern, with scattered iridescent scales about the base, venter paler than the dorsum, with a pair of dark lateral stripes and a median dark spot; *legs*, 4–3–1–2, brown, anterior pairs with scattered iridescent scales, femora darker, spines, anterior patellae with a prolateral spine, posterior patellae with a retrolateral spine, all spines very small, III and IV tibiae with a dorsal basal spine, I pair, not enlarged, tibia, ventral, 2–2–2, longer than in the male, no lateral, metatarsus, ventral, 2–2–2, no lateral, II pair, spines as on the I pair, III and IV metatarsi with a distal and median whorl of spines, IV metatarsus longer than IV tibia; *epigynum*, area wider than long, two round sacs beneath the surface, separated by less than a radius, with a small dark spot near the anterior margin and a second spot above.

Lectotype ♂ Jamaica; Mandeville, Peckham Coll. M.C.Z. No. B. 0151.

Lectotype ♀ Jamaica; Mandeville, Peckham Coll.

Paratypes ♂ ♀ Jamaica; Mandeville, Peckham Coll.

A male and a female were selected from the type vial and designated lectotypes, and the above description is based on them. Several important characters have been noted that the Peckhams did not mention, and which Emerton did not show in the figures. There is a short thoracic groove in both sexes. The mandibles have a very short fang groove, with one tooth on the lower margin in the female but none in the male. The maxillae are not enlarged or modified, the anterior metatarsi have three pairs of ventral spines and the posterior metatarsi have two whorls of spines. The spinnerets are unusually long and the dorsal pair are separated to show the median pair. The ventral pair is the same length as the median pair but heavier. The genus *Maeota* was based by Simon on a species from Brazil, that has

the second row of eyes midway between the first and third rows. In this genus the maxillae have a small hook on the upper angle and the third metatarsus is longer than the fourth.

## Genus MENEMERUS Simon 1864

### MENEMERUS BIVITTATUS (Dufour)

*Salticus bivittatus* Dufour, 1831, p. 369, pl. 11, fig. 5. "♀ Hispaniola."

A cosmotropical species that is common in all parts of the world. It was reported by the Peckhams in 1901 from Port Antonio.

♂ Jamaica; Kingston, 1909, (Barbour).
♀ Jamaica; Kingston, 27–29 August 1934, (Darlington).
♂ Jamaica; Surrey, Bath, 300 feet, 1 April 1937, (Roys).

## Genus METAPHIDIPPUS F.O.P.-Cambridge 1901

### METAPHIDIPPUS PRUDENS (Peckham)

*Dendryphantes prudens* Peckham, 1901, p. 15, figs. 13–13b. "2♂ 1♀ Jamaica; Kingston, Peckham Coll."

Male. Length, 3.5 mm., ceph. 1.7 mm. long, 1.4 mm. wide, abd. 2.0 mm. long.

*Cephalothorax* brown, with broad lateral stripes of white scales that do not meet posteriorly, ocular area paler, but the oblique stripes of white hairs figured by Emerton from the dorsal to the anterior central eyes have now disappeared, cephalic portion high, widest posterior to the dorsal eyes, thoracic groove short and faint on the slope posterior to the dorsal eyes; *eyes*, anterior row recurved by the upper margins, a.m.e. large, almost touching, a.l.e. less than a radius of a.m.e. and separated from them by less than a radius of a.l.e., second row of eyes nearer the first than the third row, dorsal eyes on the extreme margin of the carapace, subequal with a.l.e.; *quadrangle* slightly wider behind than in front; *clypeus* below a.m.e. less than a radius of a.m.e. and retreating; *mandibles* brown, vertical, and small, fang groove horizontal, lower margin with one tooth; *labium* dark brown, longer than wide; *maxillae* more than twice as long as the labium, outer upper angle produced in a long lobe; *sternum* dark brown, oval; *abdomen* oval, now so faded that all traces of a pattern have disappeared; *legs*, much broken and faded, so that all coloring has disappeared, a few white

scales remain in I tibia, I pair enlarged, spines, I pair, patella, 0, tibia, ventral, 2–2–2, prolateral row confined to the distal third, retrolateral row on the distal two-thirds, metatarsus, ventral, 2–2, posterior pairs spineless; *palpus* not as long as the cephalothorax, brown, with a few white scales on the femur, femur slightly bent, tibia shorter than the patella, tibial apophysis not as long as the diameter of the joint and the tip turned downward, bulb extending beyond the cavity and covering the tibia, projecting on the side opposite the tibial apophysis into a distinct lobe, embolus at the tip of the bulb, broad and flat, with the outer angles of the tip chitinized in points. (Emertons figures of the palpus are good.)

Female. Length, 4.1 mm., ceph. 1.7 mm. long, 1.1 mm. wide, abd. 2.1 mm. long.

*Cephalothorax* brown, with a thin covering of white hairs, no broad lateral stripe as in the male, cephalic portion very high, widest posterior to the dorsal eyes, thoracic groove short and faint in a slight depression posterior to the dorsal eyes; *eyes* as in the male; *maxillae* not produced in a lobe on the upper outer angle; *abdomen* too faded to trace any pattern; *legs*, 4–1–2–3, faded and brittle; *epigynum* with a very deep narrow notch at the posterior margin, with an oval clear sac each side, in the anterior portion a pair of widely separated oblique openings with two sacs between, beneath the surface.

Lectotype ♂ Jamaica; Kingston, Peckham Coll. M.C.Z. No. B. 0155

Lectotype ♀ Jamaica; Kingston, Peckham Coll.

Co-type ♂ Jamaica; Kingston, Peckham Coll.

The specimens are faded and brittle, so that the color pattern has disappeared. The male type is in fragments. The species has been found in Cuba and Hispaniola.

## Genus PARADECTA gen. nov.

*Cephalothorax*, *eyes*, and *mandibles* as in *Compsodecta*; *maxillae* some times with no scopula, distal half almost circular in outline, and elevated in a cone, often ending in a chitinized point or hook; *sternum* about three-quarters as wide as long; *legs*, 4–1–2–3, spines, I pair, patella, prolateral, 1, tibia, ventral, 2–2–2, lateral, 2–2, metatarsus, ventral, 2–2, the prolateral row of spines long and from a raised base, all spines longer than the diameter of the joint; *palpus*, long and slender, patella longer than the tibia, both joints flattened dorsally, cymbium about as long as the tibia, bulb confined to the cavity and the embolus a spiral curve at the tip.

Genotype *Paradecta festiva* spec. nov.

The genus *Paradecta* is separated from *Compsodecta* Simon, by the lack of a scopula on the maxillae, the distal half of the maxillae almost circular in outline and elevated in a cone, and the much wider sternum.

### Paradecta darlingtoni spec. nov.

Figures 16, 20, 21

Male. Length, 6.0 mm., ceph. 2.5 mm. long, 2.1 mm. wide, abd. 3.0 mm. long.

*Cephalothorax* light yellow, paler in the ocular area, eyes surrounded by heavy black rings, a thin covering of fine dark hairs over the entire carapace, a row of orange-red hairs above the anterior eye row, cephalic portion high and level, sides vertical and parallel, slightly wider posterior to the dorsal eyes, a procurved depression posterior to the dorsal eyes, thoracic portion slopes rapidly from just behind the eyes to the poster or margin, thoracic groove short and faint in the depression posterior to the eyes; posterior margin less than half that of the anterior margin; *eyes*, anterior row slightly recurved by the upper margins, cover the anterior margin, eyes equidistant, separated by less than a radius of a.m.e., a.m.e. very large, a.l.e. little more than a radius of a.m.e., eyes of the second row midway between the first and third rows, dorsal eyes on the extreme margin of the carapace, slightly larger than a.l.e. and on a low tubercle; *quadrangle* about the same width in front as behind; *clypeus* retreating, below a.m.e. less than a radius of a.m.e., with a marginal fringe of white hairs; *mandibles* brown, vertical, granulate, outer margin with a distinct carina, basal half strongly convex on the outer margin and produced in a slight swelling midway between the base and the fang, a sharp tooth directed forward at the lower outer angle above the base of the fang, fang groove slightly oblique, rather short, upper margin with two small teeth near the median margin, lower margin with one large tooth, fang short with a thick base; *labium* pale brown, about twice as long as wide, tip rebordered; *maxillae* one and a half times as long as the labium, basal half narrow and arched from the plane, distal half almost circular, no scopula, with posterior margin heavily chitinized; *sternum* pale brown, oval, fully twice as long as wide, convex, I pair of coxae separated by less than a diameter, IV pair of coxae contiguous; *abdomen* covered with short hairs, a wide median pale stripe with irregular dark stripes each side, venter pale with a wide median dark stripe, posterior spiracle a short transverse slit anterior to the spinnerets with chitinized margins and thinly covered with short dark hairs; *legs*, 4–3–1–2, pale brown, with faint darker rings on all joints, I pair slightly enlarged, spines,

I pair, patella, lateral, 2, tibia, ventral, 2–2–2, opposite and third pair basal, lateral, 2–2, metatarsus, ventral, 2–2, lateral, 2–2, ventral spines much heavier than tibial spines, posterior pairs spiny, III and IV tibiae with a dorsal basal spine, IV metatarsus with a distal whorl of 5 spines, 1 dorsal; *palpus* brown, longer than cephalothorax, femur with a stout median dorsal spine at the tip, patella a little longer than the femur but appearing much longer as it is slender, flattened dorsally and ventrally, with a median dorsal carina, ending in a long trichobothria (?), arising from a very small tubercle, tibia two-thirds as long as the patella, with a dorsal carina, and two ventral processes near the tip and a sharp tibial apophysis not as long as the diameter of the joint, a prolateral scant fringe of long white hairs, cymbium not quite as long as the tibia, bulb convex and confined to the cavity, quite small, embolus a spiral curve at the tip.

Holotype ♂ Jamaica; Blue Mountains, Main Range, south-west side, 3,000–4,000 feet, 18 August 1934, (Darlington). M.C.Z. No. B.0160.

### Paradecta festiva spec. nov.

Figures 17, 19, 22, 23

Male. Length, 5.4 mm., ceph. 2.5 mm. long, 1.7 mm. wide, abd. 2.6 mm. long, 1.5 mm. wide.

*Cephalothorax* chestnut-brown, shining, with a short median pale stripe from the line of the posterior eyes, not reaching the posterior margin, cephalic portion high, sides almost parallel, a faint recurved depression between the dorsal eyes, thoracic groove short between the posterior eyes; *eyes* surrounded by black, anterior row slightly recurved by the upper margins, eyes equidistant, a.m.e. large, separated by less than a radius, a.l.e. about a radius of a.m.e., second row about midway between the first and third rows, dorsal eyes on the extreme margin of the carapace and slightly larger than a.l.e.; *quadrangle* plainly narrower behind than in front; *clypeus* below a.m.e. about a radius of a.m.e. with no hairs or scales; *mandibles* dark brown, vertical, about twice as long as wide, retrolateral margin with a chitinized keel, widest very near the base and ending in a sharp tooth above the base of the fang, on the prolateral margin and about opposite, a smaller tooth, front area with a median elevated ridge most distinct near the base, striated, fang groove slightly oblique, upper margin with two teeth, lower margin with one tooth; *labium* brown, longer than wide, tip rebordered; *maxillae*, basal half brown, narrow, distal half pale, and almost circular, lower angle protruding in a cone with a chitinized tip,

best seen in a lateral view; *sternum*, with a pale center, three-quarters as wide as long, convex; *abdomen* oval, with a median pale stripe, narrow at the base and gradually widening to twice the width on the posterior half, with vague dark cross bars, venter pale, with a median darker stripe, spinnerets, dorsal pair separated, ventral pair touching; *legs*, 4–1–2–3, not varying much in length, I pair enlarged, patellae, tibiae and metatarsi with dark rings, more distinct on the posterior pairs, spines, I pair, patella, prolateral, 1, tibia, ventral, 2–2–2, lateral, 2–2, metatarsus, ventral, 2–2, spines of the prolateral row long and from a raised base, all spines longer than the diameter of the joint, II pair, same as I pair but smaller, III and IV tibiae with a dorsal basal spine, IV metatarsus, with two whorls of spines; *palpus*, as long as the cephalothorax, brown, femur, tip truncate with two parallel spines and a slightly larger posterior spine, patella a little shorter than the femur, (5 : 6), flattened dorsally with lateral carinas, wider at the tibial end with a long trichobothria at the tip, tibia flattened dorsally with a prolateral carina, and two ventral lobes near the tip, a scant ventral fringe of long white hairs, tibial apophysis long and slender, almost as long as the diameter of the joint, pressed close to the cymbium, cymbium about as long as the tibia, bulb confined to the cavity, embolus a spiral curve at the tip.

Female. Length, 5.5 mm., ceph. 2.5 mm. long, 1.6 mm. wide, abd. 2.7 mm. long, 2.5 mm. wide.

*Cephalothorax* pale brown, paler than in the male and the dark rings about the eyes wider; *eyes* same as in the male; *clypeus* below a.m.e. about a radius of a.m.e., covered with white hairs; *mandibles*, pale, vertical, not modified, fang groove oblique, short, upper margin with two teeth, lower margin with one tooth; *labium* same as in the male; *maxillae* pale, distal half not enlarged; *sternum* same as in the male; *abdomen* pale, sides with reddish-brown hairs, but no indication of the pattern found in the male, venter pale, dorsal spinnerets separated to show the median pair, ventral pair touching; *legs*, 4–3–1–2, varying little in length, pale with faint indications of the dark rings, spines same as in the male; *epigynum*, area about as wide as long, a narrow median septum divides the area into two depressed areas in the anterior half, below are large dark sacs beneath the surface; the openings are probably small circular spaces on the outer margins of the anterior ovals.

Holotype ♂ Jamaica; Blue Mountains, Main Range, southwest side, 3,000–4,000 feet, 13 August 1934, (Darlington). M.C.Z. No. B.0162.

Allotype ♀ Jamaica; Blue Mountains, Main Range, southwest side, 3,000–4,000 feet, 13 August 1934, (Darlington).

PARADECTA GRATIOSA spec. nov.

Figures 24, 28, 29

Male. Length, 5.5 mm., ceph. 2.6 mm. long, 1.6 mm. wide, abd. 2.5 mm. long, 1.3 mm. wide.

*Cephalothorax* brown, ocular area almost black, a narrow marginal pale stripe on the posterior half, and a narrow median pale band of iridescent scales covers the posterior half of the ocular area, cephalic portion very high, sloping gradually to the posterior margin, sides almost parallel, a narrow recurved depression between the dorsal eyes, thoracic groove short and faint posterior to the dorsal eyes; *eyes*, anterior row straight by the upper margins, eyes equidistant, a.m.e. large, separated by less than a radius, a.l.e. about a radius of a.m.e., small eyes midway between the first and third rows, dorsal eyes subequal with a.l.e.; *quadrangle* slightly narrower behind than in front; *clypeus* below a.m.e. more than a radius of a.m.e., no scales or hairs; *mandibles* dark brown, about two-thirds as wide as long, basal half slightly convex and roughened with a slight swelling on the exterior margin about the middle, distal half almost flat, with a long sharp tooth or cusp a little above the base of the fang and at right angles to the plane of the mandible, and a much smaller tooth opposite near the median margin, fang groove almost horizontal, upper margin with two teeth, lower margin with one sharp tooth, fang long; *labium* pale, longer than wide, tip rebordered; *maxillae* almost twice as long as the labium, basal half brown, arched from the plane, distal half pale, slightly widened and the lower outer angle prolonged in a large elevated lobe, no scopula; *sternum* pale, as wide as long, convex, IV coxae separated by about a radius; *abdomen*, basal half dark with three pale stripes, distal half with a large dark spot followed by two dark bars near the tip, venter pale, with scattered dark spots, the largest over the opening of the posterior spiracle, spinnerets, dorsal pair separated showing the slender median pair between, ventral pair stouter and touching; anal tubercle very distinct; *legs*, 4–3–1–2, differing little in length, first pair heaviest, and darker, posterior pairs distinctly ringed, all tarsi pale, spines, I pair, patella, prolateral, 1, tibia, ventral, 2–2–2–2, the second from the distal end, smaller and slightly out of line, lateral, 2–2, metatarsus, ventral, 2–2, lateral, 2–2, all spines less than the diameter of the joint and slender, II pair, spines the same as the I pair, III and IV tibiae with a dorsal basal spine, IV metatarsus with two whorls of spines; *palpus* as long as the cephalothorax, pale, patella not flattened dorsally, with a long trichobothria at the tip, tibia slightly longer than the patella, and flattened dorsally and depressed ventrally, with a prolateral tuft of iridescent long white hairs near the

tip, tibial apophysis pale, triangular, cymbium not as long as the tibia, bulb confined to the cavity, embolus a short spiral curve at the tip.

Holotype ♂ Jamaica; Blue Mountains, Main Range, 5,000–7,000 feet, 17–19 August 1934, (Darlington). M.C.Z. No. B.0161.

Paratypes 3 ♂ Jamaica; Blue Mountains, Main Range, 5,000–7,000 feet, 17–19 August 1934, (Darlington).

*Paradecta gratiosa* has several characters that do not agree very well with the diagnosis of the genus. The mandibles have no tooth on the external margin, the clypeus is wider than in other species of the genus, and the spines of the legs are much smaller, with an additional pair of ventral spines on the anterior tibiae. The relative length of the joints of the palpus also differs. The patella is shorter than the tibia, and is not flattened dorsally, but the palpal organ is the same as in the other species of the genus.

The paratypes are larger than the type, (7.0 mm.), but otherwise the same. The posterior spiracle in some specimens is distinct, as a straight slit with chitinized margins, about one-third the width of the abdomen.

### Paradecta valida spec. nov.

Figures 25, 26, 27

Male. Length, 6.00 mm., ceph. 3.0 mm. long, 2.0 mm. wide, abd. 3.5 mm. long, 1.8 mm. wide.

*Cephalothorax* a bright brown, eyes heavily ringed with black, a narrow median stripe covered with white scales includes the thoracic groove but does not reach the posterior margin, cephalic portion high, widest posterior to the dorsal eyes, thoracic portion slopes gradually from the groove to the posterior margin, sides rounded, thoracic groove in a recurved depression between the dorsal eyes; *eyes*, anterior row slightly recurved by the upper margins, eyes equidistant, a.m.e. very large, separated by a little more than a line, a.l.e. about a radius of a.m.e., eyes of the second row midway between the first and third rows, dorsal eyes not on the extreme margin of the carapace, slightly raised and a little larger than the a.l.e.; *quadrangle* slightly narrower behind than in front; *clypeus* below a.m.e. less than a radius of a.m.e., with no hairs or scales; *mandibles* vertical, dark brown, each mandible about twice as long as wide, a distinct carina on each margin, the tooth or swelling on the retrolateral margin one-third nearer the base than to the fang groove, and small, mandibles slightly depressed and transversely striate, the retrolateral carina ending in quite a large tooth which projects forward at the base of the fang, prolateral carina ending before the fang groove and followed by a sharp tooth, fang

with a heavy base, groove short and horizontal, upper margin with two teeth, lower margin with one sharp tooth; *labium* brown, longer than wide, with a rebordered tip; *maxillae* nearly twice as long as the labium, basal portion narrow, sides parallel, distal portion pale, circular, with a scant scopula, and elevated in a cone ending in an incurved hook, all outside the plane of the labium and the maxillae; *sternum* pale, oval, three-quarters as wide as long, convex, with no hairs; *abdomen* oval, with few hairs and no scales, a pale median stripe, constricted posterior to the middle, bordered with a dark stripe of equal width, widened posterior to the middle, posterior portion of the pale stripe with scattered dark dots and vague chevrons, venter with a dark median stripe, darker over the posterior spiracle, which is a straight slit with chitinized margins; the dorsal pair of spinnerets separated by a diameter, showing the pale median pair, ventral pair contiguous; *legs*, 1–3–4–2, varying little in length, brown, with distal joints darker, first pair, femur enlarged, with a ventral chitinized lobe one-third nearer the distal end, with area slightly concave, patella flattened dorsally, spines, patella, lateral, 2, tibia, ventral, 2–2–2, lateral, 2–2, metatarsus, ventral, 2–2, prolateral row spines from a raised base and the basal pair very long, lateral, 2–2, the fourth pair of legs has been renewed recently, but on a paratype, the fourth metatarsus has a distal whorl of 5 spines, 1 dorsal; *palpus*, brown, longer than the cephalothorax, femur and patella subequal, femur bent and the tip truncate, bearing two heavy spines from a raised base and a longer posterior spine, patella flattened dorsally with a prolateral carina, sides only slightly rounded, tibia little over half as long as the patella, with a prolateral carina, thickened ventrally at the distal end with a blunt lobe, tibial apophysis a short triangular spur, less than the diameter of the joint and pressed close to the cymbium, cymbium relatively small, not as long as the tibia, bulb confined to the cavity, embolus a small spiral curve at the tip.

Holotype ♂ Jamaica; Blue Mountains, Main Range, 5,000–7,000 feet, 17–19 August 1934, (Darlington). M.C.Z. No. B.0163.

Paratype ♂ Jamaica; Blue Mountains, Main Range, 5,000–7,000 feet, 17–19 August 1934, (Darlington).

## Genus PARASAITIS gen. nov.

*Cephalic* portion very high, sides parallel and vertical, thoracic groove short and faint; *eyes*, anterior row recurved, a.m.e. large and almost touching, a.l.e. about half a diameter of a.m.e., small eyes midway between first and third rows, dorsal eyes on the extreme

margin of the carapace and subequal with a.l.e.; *quadrangle* slightly wider behind than in front; *mandibles* vertical, not modified, fang groove short with no teeth on either margin of the male; *labium* longer than wide; *maxillae* with a small point on the upper outer margin; *legs*, 4–3–1–2, first femur enlarged, spines, I pair, patella, lateral, 2, tibia, ventral, 2–2–2, no lateral or dorsal, metatarsus, ventral, 2–2, no lateral, III and IV tibiae with a dorsal basal spine, IV metatarsus, with two whorls of four spines; *palpus* as long as the cephalothorax, patella and tibia flattened dorsally, tibia not as long as the patella, bulb extending onto the tibia, embolus a coil at the tip.

Genotype *Parasaitis femoralis* spec. nov.

The genus *Parasaitis* differs from the genus *Saitis* Simon in having no teeth on either margin of the fang groove, the labium longer than wide, the fourth pair of legs longer than the third pair, the femur of the first pair distinctly enlarged on the ventral side, the patella and tibia of the palpus flattened dorsally, and the bulb confined to the cavity.

### Parasaitis femoralis spec. nov.

Figures, 30, 31, 32

Male. Length, 3.5 mm., ceph. 2.0 mm. long, 1.5 mm. wide, abd. 1.8 mm. long.

*Cephalothorax* dark brown, paler in the ocular area, with a median pale stripe from the dorsal eyes ending abruptly a short distance from the posterior margin, a narrow marginal stripe of white hairs on the posterior third, a few white hairs between the lateral eyes and scattered golden scales on the ocular area, cephalic portion very high, thoracic sloping gradually on the anterior half and then abruptly to the posterior margin, sides parallel and vertical, thoracic groove short and faint, slightly posterior to the dorsal eyes; *eyes* cover two-thirds the carapace, anterior row recurved, a.m.e. almost touching, a.l.e. about one-half the diameter of a.m.e. and separated from them by fully twice the space between a.m.e., a few long bristles between a.m.e. and between a.m.e. and a.l.e., small eyes midway between first and third rows, third row on the extreme margin of the carapace and eyes subequal with a.l.e.; *quadrangle* slightly wider behind; *clypeus* below a.m.e. about a radius of a.m.e., dark brown with no hairs or scales; *mandibles* dark brown, tip cream-colored, no hairs or scales, not modified, fang groove horizontal, very short with no teeth on either margin; *labium* dark brown, longer than wide; *maxillae* almost twice as long as the labium, basal half very narrow, tip widened and developed in a small point; *sternum* pale, oval, two-thirds as wide as long, I coxae separated

by more than a diameter, IV coxae almost touching; *abdomen* oval, with a pale median stripe slightly wider on the distal half, with small paired dark dots, a narrow lateral pale stripe on basal half, venter almost covered by a dark triangle, small dark dots on the pale lateral areas, posterior spiracle covered with a short chitinized straight line, spinnerets, dorsal pair of two joints, basal joint long, separated by fully three diameters, showing the median pair, not quite as long as the dorsal pair, ventral pair almost touching; *legs*, 4–3–1–2, all tarsi pale, I and II femora dark, III and IV femora pale, I pair, femur enlarged by a ventral prolateral thickened ridge, so that the joint is much thickened in the dorsal ventral diameter, patella pale, tibia darker at the tip, metatarsus with a dark basal and distal bands, spines, patella, lateral, 2, tibia, ventral, 2–2–2, no lateral, metatarsus, ventral, 2–2, basal pair three-quarters the length of the joint, II pair, femur dark but not modified, III and IV tibiae with a dorsal basal spine, IV metatarsus with 2 whorls of 4 spines, IV patella and tibia longer than corresponding joints of the III pair; *palpus* as long as the cephalothorax patella two-thirds as long as the femur, flattened dorsally, widest in the middle with a ventral fringe of long white hairs, tibia about two-thirds as long as the patella, flattened dorsally, cymbium about as long as the tibia, bulb short, not prolonged onto the tibia, embolus at the distal end, forms almost a complete circle with the tip at the end of the cymbium.

Female. Length, 4.0 mm., ceph. 2.1 mm. long, 1.6 mm. wide, abd. 2.0 mm. long, 1.5 mm. wide.

*Cephalothorax* dark brown, shining, a median pale stripe from the dorsal eyes to the posterior margin, and a pale lateral stripe above the margin from the clypeus to the posterior margin, cephalic portion high, sloping gradually from the dorsal eyes to the posterior margin, sides parallel and vertical, thoracic groove short and faint, slightly posterior to the dorsal eyes; *eyes* as in the male; *clypeus* pale, with a few white scales about the a.m.e., less than a radius of a.m.e., with a pair of long bristles below and between the a.m.e. directed upward; *mandibles* vertical, basal half dark brown, fang groove horizontal, upper margin with 2 small teeth, lower margin with one large tooth, fang with a heavy base; *labium* pale, longer than wide; *maxillae* pale, basal half very narrow, tips not modified; *sternum* dark, with a median pale stripe, wide at the anterior end and narrower at the tip, two-thirds as wide as long, IV coxae almost touching; *abdomen* dark, with a narrow median pale stripe on the basal half and three dark chevrons at the tip, venter pale with dark spots, the largest over the posterior spiracle, which is covered by a chitinous lobe; spinnerets, dorsal spinnerets separated to show the median pair, ventral pair the same length,

separated by about half a diameter, pale with a lateral dark stripe and a dark spot at the base; *legs*, 4–1–2–3, pale with dark rings, femora and tibiae with three dark rings most distinct on the dorsal side, I femur thickened but not modified, spines as in the male, but the basal pair on the first metatarsus not as long, two whorls of 4 spines on the fourth metatarsus, palpus pale, with dark rings at the base of the femur, patella, and tibia; *epigynum*, area slightly wider than long, a pair of clear oval depressions, separated by a narrow septum, each containing an oblique clear oval with a small dark spot at the posterior margin, and a pair of circular openings at the anterior margin separated by about a diameter.

Holotype ♂ Jamaica; Blue Mountains, Main Range, southwest side, 3,000–4,000 feet, 13 August 1934, (Darlington). M.C.Z. No. B.0164.

Allotype ♀ Jamaica; Blue Mountains, Main Range, southwest side, 3,000–4,000 feet, 13 August 1934, (Darlington).

The male and female differ in the teeth of the fang groove of the mandible, but the abdominal markings and the spines on the legs are the same.

## Genus SAITIDOPS Simon 1901

### SAITIDOPS ALBOPATELLA spec. nov.

Figures 33, 34

Male. Length, 3.0 mm., ceph. 1.5 mm. long, 0.9 mm. wide, abd. 1.5 mm. long, 1.0 mm. wide.

*Cephalothorax* black and shining, a few scattered white hairs on the ocular area, and a wide lateral band of white hairs, cephalothorax fairly high, sides parallel and vertical, thoracic groove in a circular depression posterior to the dorsal eyes; *eyes*, anterior row recurved so that a straight line touching the upper margins of a.m.e. would pass through the center of a.l.e., a.m.e. large and touching, a.l.e. about a radius or less of a.m.e. and separated from them by less than a radius of a.l.e., small eyes nearer the first row of eyes than to the third, dorsal eyes smaller than a.l.e. and not on the extreme margin of the carapace; *quadrangle* plainly narrower behind than in front; *clypeus* below a.m.e. less than a radius of a.m.e., with scattered white hairs and a scant fringe of long white hairs on the margin; *mandibles* dark, vertical, with many long iridescent hairs, fang groove very short, with no teeth on either margin, fang short with a heavy base; *labium* dark, longer than wide; *maxillae* almost twice as long as the labium, distal half pale,

tips not modified; *sternum* dark, convex, shining, oval, nearly as wide as long, (3.5 : 4.0), first coxae dark, separated by more than a diameter, other coxae pale, fourth coxae almost touching; *abdomen* dark, oval, with scattered short iridescent hairs, on posterior half four pairs of short bars and a pair of pale curved lateral bars which join a white spot above the spinnerets, venter pale, spinnerets white, dorsal pair white, rather long, separated to show the median pair which form a straight line with the dorsal pair and are about as long as the dorsal pair, ventral pair dark, stout and shorter than the other two pairs; *legs*, 1–4–3–2, I pair, heaviest, dark, with many dark hairs, other pairs with a wide pale basal band, less strongly marked on the II pair, tarsi pale and short, tibiae with two pale bands, spines, I pair, patella, 0, tibia, 0, metatarsus, prolateral, 1 at base, posterior pairs with long spines on tibiae; palpus not as long as cephalothorax, patella and tibia pale, with lateral crests on tibia of long iridescent hairs, so that the joint appears much wider, cymbium a little darker, patella twice as long as the tibia, tibial apophysis a sharp dark spine about as long as the diameter of the joint, bulb extending onto the tibia in a small pointed lobe, embolus a short straight spine at the tip.

Holotype ♂ Jamaica; Blue Mountains, Maine Range, 5,000–7,000 feet, 17–19 August 1934, (Darlington). M.C.Z. No. B.0165.

Paratype ♂ Jamaica; Blue Mountains, Main Range, 5,000–7,000 feet, 17–19 August 1934, (Darlington).

The position of the genus is uncertain. It was based by Simon on a small male found at Valencia, Venezuela and placed by him (Histoire Naturelle des Araignées, 1903, 2:669) in the *AElurillae* near *Habrocestum*. Most of the genera in this group are from the Old World. Petrunkevitch in 1928, placed both *Habrocestum* and *Saitidops* in the *Pelleninae*.

The genus was described as having the anterior row of eyes straight, the a.m.e. large and touching, and the quadrangle narrower behind than in front, the fang groove short, with no teeth on either margin, and the first tibia with no spines. The genotype, *S. clathratus* Simon, is described as 3.0 mm. long, dark and shining, with large iridescent scales. The palpus has the patella longer than the tibia, and both joints are covered with long white hairs.

This is another example of the close relationship of the fauna of the northern part of South America and the mountains of the islands of the Caribbean.

## Genus SILOCA Simon 1901

### SILOCA (?) VIARIA (Peckham)

*Prostheclina viaria* Peckham, 1901, p. 14, figs. 11–11b. "2♂ [Jamaica]; Moneague."

Male. Length, 2.8 mm., ceph. 1.6 mm. long, 1.0 mm. wide, abd. 1.1 mm. long, 0.6 mm. wide.

*Cephalothorax* brown, with a few iridescent hairs, quite high, sides vertical, highest at the dorsal eyes, slopes gradually half way to the posterior margin and then falls rapidly, thoracic groove short in a circular depression; *eyes* cover the anterior margin, anterior row slightly recurved by the upper margins, a.m.e. very large and almost touching. a.l.e. slightly less than a radius of a.m.e., and separated from them by a line, second row of eyes about midway between the first and third rows, dorsal eyes on the extreme margin of the carapace, and slightly larger than a.l.e.; *quadrangle* narrower behind than in front; *clypeus* below a.m.e. about half a radius of a.m.e., with a narrow band of white hairs on the margin; *mandibles* brown, narrow and vertical, with a distinct U-shaped carina on the distal half, fang groove horizontal, upper margin with 2 (?) teeth, lower margin with one strong tooth; *labium* brown, as wide as long; *maxillae* about twice as long as the labium, tips only slightly widened, basal half distinctly bowed outward; *sternum* pale brown, two-thirds as wide as long, convex, fourth coxae almost touching; *abdomen* brown, faintly mottled, a pale gray chevron on the posterior half, venter brown with the distal half paler, spinnerets, dorsal pair separated showing the median pair; *legs*, 1–4–2–3, varying little in length, all tarsi short, femora of anterior pairs slightly enlarged, I pair, all joints but tarsus brown, II, III and IV pairs, all joints with alternate dark and pale bands, spines, I pair, patella, lateral, 2, tibia, ventral, 2–2–2, lateral, 2–2, metatarsus, ventral, 2–2, basal pair almost as long as the joint, lateral, 2, posterior metatarsi with 2 whorls of spines; *palpus* shorter than cephalothorax, brown, femur with a dorsal crest of white hairs on distal half, patella slightly longer than the tibia, tibia little longer than the diameter. tibial apophysis slender, pressed close to the cymbium, not as long as the diameter of the joint, bulb globose, confined to the cavity, tube with an S-shaped curve and embolus at the tip in a spiral curve.

Lectotype ♂ Jamaica; Moneague, Peckham Coll. M.C.Z. No. B.0153.

Co-type ♂ Jamaica; Moneague, Peckham Coll.

The two males from Moneague are broken and discolored by age, but the palpi remain and several of the legs.

The generic position of *Prostheclina viaria* Peckham is uncertain. The genus *Prostheclina* was based by Keyserling on several species from Australia and later synonymized by Simon with *Saitis*. The species *viaria* does not belong in the genus *Saitis*, as the third pair of legs is not the longest, there are lateral spines on the anterior tibiae, and in the palpus the embolus is a spiral curve rather than straight.

It does not belong to the genus *Oningis* Simon, as the posterior pairs of legs are distinctly spined. Neither can it be placed in the genus *Stoides* Simon, based on the species *Prostheclina pygmaea* Peckham from St. Vincent, as in that species, the upper margin of the fang groove has no teeth, and the anterior row of eyes is described as turned downward, so that they can not be seen from the dorsal side.

It agrees quite well with the genus *Siloca* Simon, 1901, based on the species *sanguiniceps* Simon from Brazil, except that the latter has a bifid tooth on the lower margin of the fang groove, but it does agree with the number of spines on the legs, with the very long basal pair on the anterior metatarsi and with the whorls on the posterior metatarsi.

The U-shaped carina on the mandibles may be only specific, not generic. Neither the Peckhams or Emerton noticed it.

## Genus THIODINA Simon 1900

*Thiodina* Simon, 1900, p. 392, genotype *Attus elegans* Nicolet.
*Nilacantha* Simon, 1901, p. 459, genotype, *Nilacantha cockerelli* Peckham, ♂ ♀
*Nilakantha* Peckham, 1901, June, p. 8, genotype *Nilakantha cockerelli* Peckham, ♂ ♀
*Colonus* F.O.P.-Cambridge, 1901, June, p. 246, genotype *Attus puerpera* Hentz, ♂ ♀

The generic position of *Thiodina* is confusing, as the number of teeth on the lower margin of the fang groove varies according to the sex and species. The genotype, *Attus elegans* Nicolet, from Peru is unknown to me. Simon states in the original description of the genus, that the upper margin of the fang groove has four contiguous teeth and that the number of teeth on the lower margin varies according to the species. In *Thiodina puerpera* (Hentz), this species in both sexes, may have a compound or a single tooth on the lower margin, and in some species there are several teeth on this margin, so that this genus could be placed in any of the three major divisions of the family as divided by Simon in the Histoire Naturelle des Araignées.

The Peckhams' description of the genus *Nilakantha* is vague, and it is separated from the genus *Thiodina* by the smaller size, and the greater difference in the size of the eyes of the anterior row. No

mention is made of the ventral bulbous spines on the anterior tibiae. Simon separates the two genera, *Thiodina* and *Nilacantha*, by the lack of the anterior pair of ventral spines on the second tibia, and the three whorls of spines on the fourth metatarsus. The number of tibial spines is rather a weak character on which to base a genus, where all the spines are short and weak, and both *Thiodina* and *Nilacantha* have two complete and an incomplete whorl of spines on the fourth metatarsus. Apparently, neither Simon nor Peckham noticed the two pairs of ventral bulbous hairs on the anterior tibiae. These are present on both the first and second tibiae and are very slender.

F.O.P.-Cambridge, in June 1901, page 287, of the Biol. Centrali-Americana, described *Attus puerpera* Hentz, and erected the genus *Colonus* for it. This is a typical species of *Thiodina*, so that *Colonus* falls into synonomy. He also described another species *Colonus crucifer*, based on a female from Panama. The description is very brief, but it agrees perfectly with *Nilacantha cockerelli* Peck., from Jamaica, in size, color, and the teeth on the fang groove. Cambridge also calls attention to the bulbous hairs on the anterior tibiae. The figure of the epigynum has the black median spot with a pair of small oval openings, followed by a broad transverse ridge, so it is not impossible that *Colonus crucifer* Cambr. and *Nilacantha cockerelli* Peck., are the same. Unfortunately both were published in June 1901.

### Thiodina cockerelli (Peckham)

Figure 18

*Nilakantha cockerelli* Peckham, 1901, p. 8, figs. 1–1f. "♂ 3 ♀ Jamaica; Moneague and Kingston."

*Cephalothorax* pale brown with four dark spots on the ocular area, separated by a bright yellow cross, three parallel lateral stripes of white hairs below the lateral eyes, not marginal, a faint broad band of white hairs posterior to the dorsal eyes, entire carapace with scattered short dark hairs, cephalic portion high, widest posterior to the dorsal eyes, thoracic portion falls sharply with the groove at the anterior end, well behind the dorsal eyes; *eyes* seen from above, in four rows, the anterior row strongly recurved, seen from in front, the upper margins form a straight line, a.m.e. very large, separated by more than a line, and almost cover the anterior margin, a.l.e. less than a radius of a.m.e. and separated from them by about a diameter of a.l.e., eyes of the second row nearer the first than the third row, and on the same dark spot as the a.l.e., dorsal eyes not on the margin of the carapace, slightly larger than the a.l.e.; *quadrangle* longer than wide;

*clypeus* below a.m.e. less than a radius of a.m.e., vertical, and covered with white hairs; *mandibles* brown, vertical, fang groove oblique, upper margin of the groove with one tooth, lower margin with one tooth; *labium* brown, longer than wide, tip rebordered; *maxillae* about twice as long as the labium, inclined, so that the tips almost touch; *sternum* pale brown, oval, about twice as long as wide, I coxae separated by little more than a diameter, IV coxae almost touching; *abdomen* pale, with a vague median dark branched stripe, sides pale, entire dorsum with scattered dark spots, venter almost covered by a broad dark stripe, opening of the posterior spiracle directly in front of the spinnerets; *legs*, 1–4–3–2, not hairy, I pair enlarged, anterior pairs dark, posterior pairs pale, all spines on anterior legs small, spines, I pair, patella, prolateral, 1, tibia, ventral, p. 1–1, r.1, basal, 2–2 bulbous hairs, metatarsus, ventral, 2–2, III and IV tibiae with a dorsal basal spine, IV metatarsus, with two complete whorls of spines, and one incomplete whorl; *palpus* not as long as the cephalothorax, basal joints white, patella and tibia about as long as the diameter of the joint, terminal joint dark, large, tibial apophysis branched as in *Thiodina*, bulb extends onto the tibia, embolus a long straight spine in a groove that reaches the tip.

Female. Length, 4.6 mm., ceph. 2.0 mm. long, 1.4 mm. wide, abd. 2.6 mm. long, 1.6 mm. wide.

*Cephalothorax* same as in the male, even to the narrow parallel lateral stripes below the lateral eyes; *eyes* same as in the male; *quadrangle* and *clypeus* same as in the male; *mandibles* too fragile to move; *abdomen* very much faded on the dorsum, with faint dark spots in diagonal rows, venter pale with faint dark spots, spinnerets, dorsal pair long, widely separated to show the slender median pair, ventral pair as long as the dorsal pair and touching; *legs*, much broken; *epigynum* area much wider than long, at the anterior end a median black spot with two small oval clear spots, followed by a rounded transverse ridge which extends the width of the area, on this a pair of widely separated clear spots and between the fold and the ridge another pair of widely separated openings.

Holotype ♂ Jamaica; Kingston, Peckham Coll. M.C.Z. No. B.0144.

Allotype ♀ Jamaica; Kingston, Peckham Coll.

♂ Jamaica; Kingston, 27–30 August 1934, (Darlington).

The Peckhams proposed the genus *Nilakantha* for this species. The types, which are now before me, are brittle and faded from age, but a few characters have been noted that were not observed by the authors or by Simon. The band of yellow hairs on the sides of the cephalothorax of the male, as noted by the Peckhams, is actually three narrow parallel lines of white hairs. These are below the lateral eyes.

Also the two pairs of ventral bulbous hairs on the anterior tibiae are distinct, although very slender, but were not seen by them.

The Peckhams state that they had a male and three females from Kingston and Moneague, but the type vial, which is marked Kingston has only a male and a female and two very immature specimens. It is possible that the Peckhams sent a female to Simon that did not belong to the genus.

## Genus WALLABA Mello-Leitao 1940

### WALLABA ALBOPALPIS (Peckham)

*Cybele albopalpis* Peckham, 1901, p. 12, figs. 3–3b.
*Compsodecta albopalpis*, Simon, 1901, p. 677.
*Compsodecta albopalpis*, Petrunkevitch, 1911, p. 613.

Male. Length, 5.5 mm., ceph. 2.1 mm. long, 2.0 mm. wide, abd. 2.5 mm. long.

*Cephalothorax* a dark brown, shining, no iridescent scales, a narrow pale stripe from the groove to near the posterior margin, cephalic portion very high, on the same plane to the thoracic groove, where it slopes gradually in a convex curve to the margin, sides vertical, widest posterior to the dorsal eyes, anterior margin fully twice as wide as the posterior, thoracic groove short in a semi-circular depression between the dorsal eyes; *eyes* seen from in front, anterior row strongly recurved, so that a straight line that would touch the upper margins of a.m.e. would cut the middle of a.l.e., a.m.e. very large, separated by a line, a.l.e. about a radius of a.m.e., and separated from them by less than a radius of a.l.e., small eyes about midway between the first and third rows, p.l.e. subequal with a.l.e., and on the extreme margin of the carapace; quadrangle plainly narrower behind than in front; *clypeus* below a.m.e. very narrow, little more than the space between a.m.e., no hairs or scales; *mandibles* dark brown, vertical, flat, rather weak, upper margin with two small teeth, lower margin with a fissident tooth or plate; *labium* dark brown, longer than wide, tip rebordered; *maxillae* not twice as long as the labium, sides parallel, and tips only slightly widened; *sternum* pale, oval, two-thirds as wide as long, convex, shining, I coxae separated by more than a diameter, IV coxae almost touching; *abdomen* pale, with vague dark marks, a pair of parallel stripes on the anterior half, with dark dots in the area between, posterior half with indistinct dark chevrons, sides dark, venter about covered by a dark spot; *legs*, 1–3–4–2, I pair slightly enlarged, femur dark, other joints pale, tibia and metatarsus with a thin fringe of long

white hairs, spines, patella, lateral, 2, tibia, ventral, 2–2–2–2, metatarsus, ventral, 2–2–2, II, III, and IV pairs, pale, II pair, spines same as on I pair but smaller, posterior pairs with dorsal basal spine on tibiae; *palpus*, about as long as the cephalothorax, brown, femur with a dorsal tuft of white hairs at the tip, patella and tibia subequal, a thin crest of white hairs on the patella and tibia, tibial apophysis longer than the diameter of the joint, cymbium longer than tibia, bulb confined to the basal two-thirds of the cymbium, does not extend onto the tibia, with an S-shaped tube, embolus at the tip in almost a complete spiral.

Holotype ♂ Jamaica; Peckham Coll. M.C.Z. No. B.0146.

The generic position of this species is very uncertain. Simon in 1903, proposed the genus *Compsodecta* for the two species, *grisea* and *albopalpis* from Jamaica, described by the Peckhams, with the former species the genotype, as Peckham had evidently sent him a specimen of it. The species *albopalpis* has several characters that preclude it from *Compsodecta*, a fissident tooth on the lower margin of the fang groove, no hook or modification of the mandibles, four pairs of ventral spines on the anterior tibiae and three pairs of ventral spines on the anterior metatarsi.

The genus *Wallaba* was erected in 1940 by Mello-Leitao for a single species from British Guiana. Both the generic and specific descriptions are meagre, but the genus has three pairs of ventral spines on the anterior metatarsi, a very unusual character in the *Salticidae*.

So far, the species is known only from the holotype. This is faded and broken, and missing one palpus. Mr. Emerton's figures are excellent, and the Peckham remarks are accurate but several characters were not considered of enough importance to be noted.

## Genus ZYGOBALLUS Peckham 1885

### ZYGOBALLUS SUAVIS Peckham

*Zygoballus suavis* Peckham, 1895, p. 173, pl. 16, fig. 6–6d. "♂ ♀ Jamaica; Mandeville, Moneague, and Kingston."

Male. Length, 3.2 mm., ceph. 1.7 mm. long, 1.4 mm. wide, abd. 2.0 mm. long, 0.6 mm. wide.

*Cephalothorax* dark brown, ocular area paler with a pair of dark spots about the middle, scattered short iridescent scales, and a large spot of white scales on the thoracic slope, scattered white scales below a.l.e., cephalic portion very high, widest at the dorsal eyes, sides almost

vertical, thoracic groove faint, thoracic slope slightly concave and half covered by the abdomen; *eyes* cover fully one half of the carapace, anterior row strongly recurved, so that a straight line touching the upper margins of a.m.e. would touch the lower margins of a.l.e., eyes equidistant, a.m.e. large, separated by about half a radius, a.l.e. less than a radius of a.m.e., eyes of the second row very small, much nearer to the first than to the third row, dorsal eyes on low tubercles and on the extreme margin of the carapace, larger than a.l.e.; *quadrangle* much wider behind than in front; *clypeus* less than a radius of a.m.e., with scattered white scales; *mandibles* dark brown, with scattered white scales, long, divergent, inner margins excavate, narrowed to the width of the fang at the tip, with a small cusp above the base of the fang and a long slender tooth on the inner margin, parallel to the tooth on the opposite mandible, best seen from the front, fang groove long and poorly defined, the usual hammer-shaped tooth on the lower margin, comparatively small, fang long and sinuous; *labium* brown, longer than wide, tip rebordered; *maxillae* brown, fully twice as long as the labium, not modified; *sternum* pale brown, shield-shaped, three-quarters as wide as long, anteriorly narrowed to the width of the labium, convex, I coxae dark brown, large; *abdomen* slender, dark, with scattered iridescent scales and paired paler spots on the basal half and indistinct chevrons on the posterior half, venter dark, spinnerets closely grouped; *legs*, 1–4–2–3, I pair longest and enlarged, dark brown, with white scales on all joints, other pairs paler with fewer scales, spines, no patellae spines, I pair, tibia, ventral, 2–2–2, not opposite, metatarsus, ventral, 2–2, II pair, tibia, ventral, 2, followed by 1–1 on the retrolateral line, prolateral, 1, metatarsus, ventral, 2–2, posterior pairs, no dorsal basal spine on tibiae, and very few ventral spines; *palpus* longer than cephalothorax, brown, femur slender and curved, with scattered white scales, patella longer than tibia, cymbium little longer than tibia, tibial apophysis not as long as the diameter of the joint, bulb confined to the cavity, embolus a short black spur at the tip.

Female. Length, 4.1 mm., ceph. 1.6 mm. long, 1.5 mm. wide, abd. 2.4 mm. long, 1.6 mm. wide.

*Cephalothorax* the same as the male, but slightly wider in proportion; *eyes*, same as in the male; *mandibles* brown, vertical, parallel, and convex, cusp over the base of the fang smaller than in the male, fang groove slightly oblique, rather short, lower margin with a large bicuspid tooth, fang long; *labium*, *maxillae*, and *sternum* as in the male; *abdomen* oval, convex, pale with a dark herring-bone median stripe, connecting with two pairs of dark spots on the posterior half, sides with dark diagonal lines, venter pale, with a pair of dark irregular lines from the

fold to the spinnerets, with dark spots between; *legs*, 4–1–2–3, I pair slightly enlarged, pale, with darker rings at the tips of the patellae, tibiae and metatarsi, spines, same as in the male; *epigynum* not large, a pair of oval openings separated by little more than a diameter and more than their diameter from the fold, which is curved, below the fold a pair of dark circular sacs that touch on the median line.

♂ ♀ Jamaica; Balaclava, f. Peckham, Peckham Coll.

♀ Jamaica; Moneague, 29 January 1929, (Brooks).

♂ ♀ Jamaica; Ocho River, 20–24 January 1929, (Brooks).

*Zygoballus suavis* was described by the Peckhams in 1895, from "numerous specimens from Mandeville, Moneague and Kingston." They probably are no longer in existence, as they were not found in the Peckham Coll. and the above description of the male was written from material collected by W. S. Brooks from Moneague, one of the type localities and of the female from a specimen from Ocho River. The figures used in the original description are by Mr. J. H. Emerton and are excellent, with the exception of the palpus, which shows the tibia and patella of equal length. In all specimens seen, the patella is always longer.

The Peckhams noted in the original description that there is a great variation in the size of the males. The largest seen is 4.5 mm. long and the smallest a little over 3.0 mm. long. The small ones are much darker.

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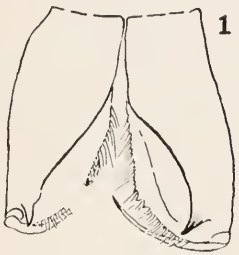
PLATE 1

## PLATE 1

Fig. 1. *Allodecta maxillaris* spec. nov., mandible.
Fig. 2. *Compsodecta defloccata* (Peckham), epigynum.
Fig. 3. *Allodecta maxillaris* spec. nov., maxilla and labium.
Fig. 4. *Anasaitis morgani* (Peckham), epigynum.
Fig. 5. *Anasaitis scintilla* spec. nov., left palpus.
Fig. 6. *Anasaitis morgani* (Peckham), left palpus.
Fig. 7. *Anasaitis decoris* spec. nov., epigynum.
Fig. 8. *Allodecta maxillaris* spec. nov., left palpus.
Fig. 9. *Anasaitis decoris* spec. nov., left palpus.
Fig. 10. *Anasaitis venatoria* (Peckham), left palpus.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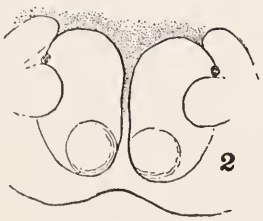
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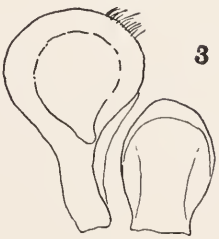
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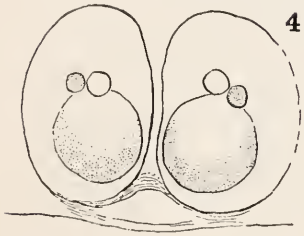
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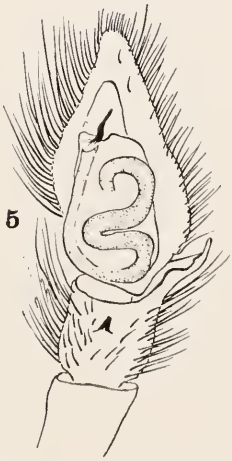
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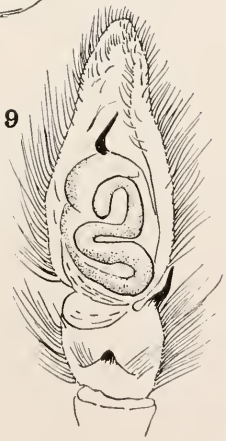
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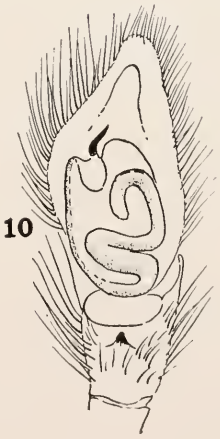
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PLATE 2

## PLATE 2

Fig. 11. *Compsodecta grisea* (Peckham), mandible.
Fig. 12. *Compsodecta grisea* (Peckham), maxilla and labium.
Fig. 13. *Compsodecta grisea* (Peckham), epigynum.
Fig. 14. *Compsodecta grisea* (Peckham), left palpus.
Fig. 15. *Compsodecta grisea* (Peckham), patella and tibia, lateral.
Fig. 16. *Paradecta darlingtoni* spec. nov., maxilla and labium.
Fig. 17. *Paradecta festiva* spec. nov., maxilla and labium.
Fig. 18. *Thiodina cockerelli* (Peckham), epigynum.
Fig. 19. *Paradecta festiva* spec. nov., left palpus.
Fig. 20. *Paradecta darlingtoni* spec. nov., left palpus.
Fig. 21. *Paradecta darlingtoni* spec. nov., patella and tibia, dorsal.
Fig. 22. *Paradecta festiva* spec. nov., left palpus.
Fig. 23. *Paradecta festiva* spec. nov., epigynum.

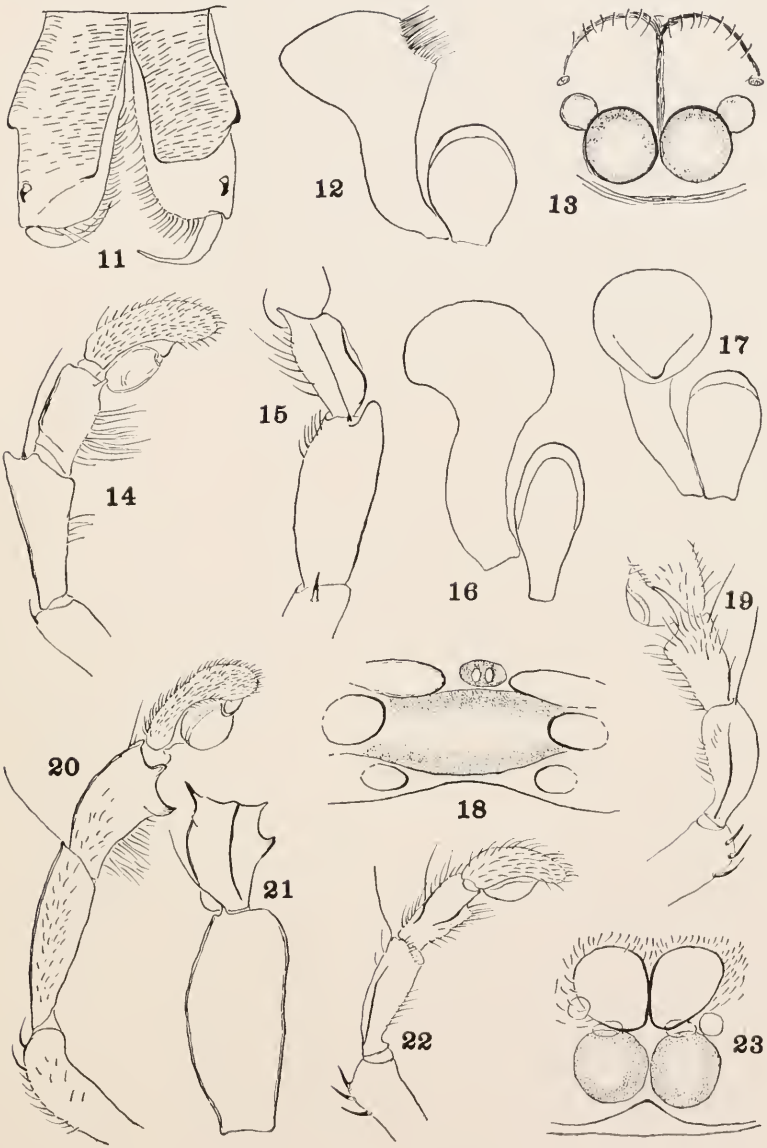
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PLATE 3

## PLATE 3

Fig. 24. *Paradecta gratiosa* spec. nov., maxilla and labium.
Fig. 25. *Paradecta valida* spec. nov., mandibles.
Fig. 26. *Paradecta valida* spec. nov., maxilla and labium.
Fig. 27. *Paradecta valida* spec. nov., left palpus.
Fig. 28. *Paradecta gratiosa* spec. nov., mandibles.
Fig. 29. *Paradecta gratiosa* spec. nov., left palpus.
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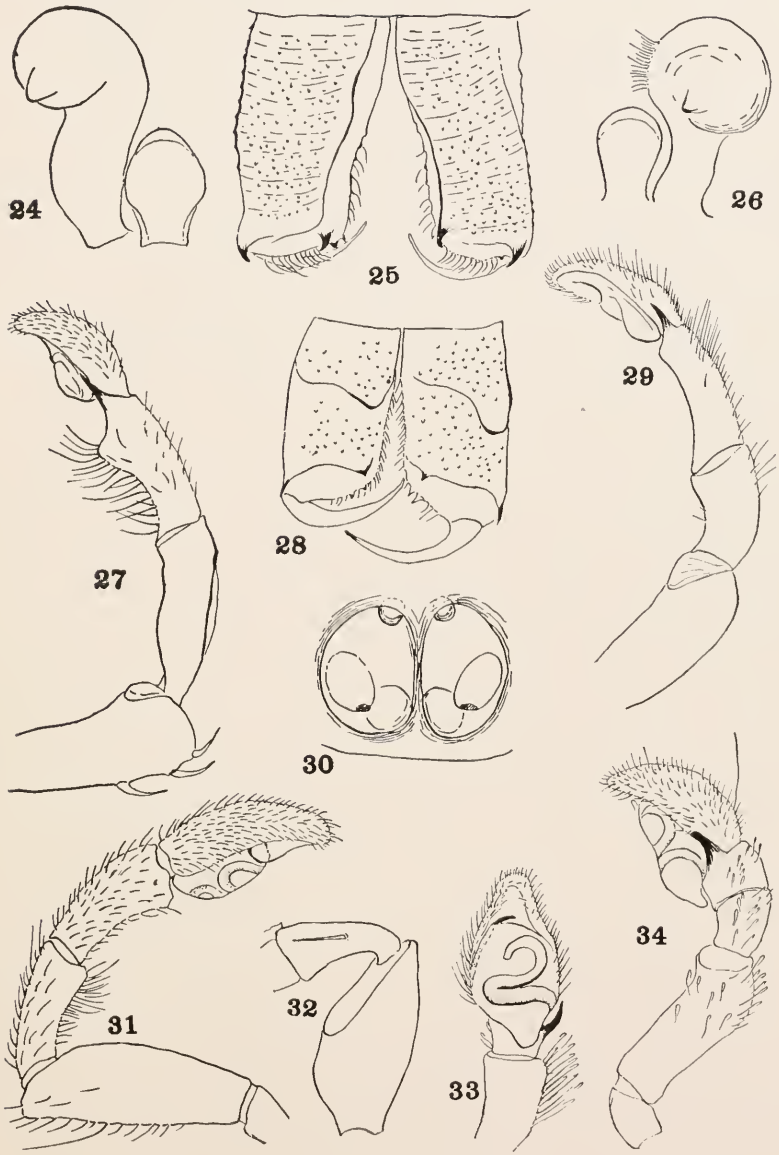
Fig. 31. *Parasaitis femoralis* spec. nov., left palpus.
Fig. 32. *Parasaitis femoralis* spec. nov., first femur and patella.
Fig. 33. *Saitidops albopatella* spec. nov., left palpus, ventral.
Fig. 34. *Saitidops albopatella* spec. nov., left palpus, lateral.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# THE SPIDER GENUS TMARUS (THOMISIDAE) IN PANAMA

BY ARTHUR M. CHICKERING

WITH FOUR PLATES

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No. 4 The Spider Genus *Tmarus* (*Thomisidae*) *in Panama*[1]

By Arthur M. Chickering
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In the course of my studies on Panamanian spiders I have been impressed by the frequency with which certain genera have shown their evolutionary success by their ability to multiply the number of species present in that region. One of the first genera to claim special attention was Dipoena (Theridiidae) in which I have already described twenty-one new Panamanian species (1943). Lyssomanes, Corythalia, Freya, Phiale, Metaphidippus, and Cobanus are very successful genera from the Salticidae (Chickering, 1946). The present paper will add Tmarus to this list which, eventually should offer a good opportunity to study the course of evolution among these animals.

The work of preparing this paper was chiefly done while I was a guest of the Museum of Comparative Zoölogy at Harvard College. It gives me great pleasure again to acknowledge my endebtedness to the following members of the staff of the Museum for their continued encouragement and repeated courtesies: Dr. A. S. Romer, Director; Dr. Joseph C. Bequaert; Miss Elizabeth B. Bryant; Mr. Ludlow Griscom, Editor of the Bulletin of the Museum of Comparative Zoölogy.

## Genus Tmarus Simon, 1875

O. P.-Cambridge (1892) described seven species of Tmarus from Panama. F. P.-Cambridge (1900) continued these studies and made minor changes but added no new species. Petrunkevitch (1925) had a single immature female from the Wilcox camp on the San Lorenzo River but he did not place it in any species. Banks (1929) reported *T. intentus* O. P.-Cambridge and *T. studiosus* O. P.-Cambridge from Fort Davis and Barro Colorado Island, C. Z., respectively. I believe that Banks' specimen identified as *T. intentus* is *T. ineptus* and I have so treated it in this paper. So far as I am aware, no other species have been described or reported from Panama until the preparation of this paper. The already known species together with those which I have recognized as new to science may be listed as follows: *Tmarus aculeatus* sp. nov.; *T. bucculentus* sp. nov.; *T. cognatus* sp. nov.; *T. contortus* sp. nov.; *T. corruptus* O. P.-Cambridge; *T. curvus* sp. nov.; *T. decens* O. P.-Cambridge; *T. ineptus* O. P.-Cambridge; *T. intentus* O. P.-Cambridge; *T. morosus* sp. nov.; *T. mundulus* O P.-Cambridge; *T. pauper* O. P.-Cambridge; *T. parki* sp. nov.; *T. peregrinus* sp. nov.;

[1] Published with the aid of a special gift from Mr. G. R. Agassiz.

*T. probus* sp. nov.; *T. productus* sp. nov.; *T. sigillatus* sp. nov.; *T. studiosus* O. P.-Cambridge. Four of these are known only from females, seven are known only from males, and the remaining seven are known from both sexes.

In order to avoid needless repetition in the descriptions certain information in which the species appear to be quite consistent is given here rather than in the material dealing with each species. The two tarsal claws are pectinated in a single row of eight or nine slender teeth. There still remains some uncertainty regarding the distribution of trichobothria and I am convinced that special attention should be given these organs in the near future. Apparently all species examined by me have trichobothria on the first pair of legs as follows: tarsus with a median dorsal row of five; metatarsus with a median dorsal row of three in distal half of segment; tibia with a dorsal row of five or six together with a loose cluster of five or six prolateral to the most proximal of the dorsal row.

### *Key to the known species of Tmarus from Panama*

#### Males

1. Species with embolus definitely and conspicuously curled either at anterior end of bulb on ventral side or on retrolateral side ..... 2
1. Species with embolus either extended more or less around margin of bulb and not definitely curled or apparently restricted to anterior end of bulb ..... 5
2. Palp: tibial apophyses short, only ventral one strongly chitinized; cymbium deeply excavate at retrolateral basal corner; embolus deeply grooved, arises near middle of anterior border of bulb, makes a complete retrolateral circle and then loops across middle of bulb again (Fig. 4) ..... *T. contortus*, (p. 224)
2. Without palpal features as given above ..... 3
3. Palp: tibia deeply excavate retrolaterally and distally; with a strongly chitinized apophysis of moderate length ventral to excavation; embolus makes a complete circle distal to anterior margin of bulb and then passes retrolaterally to terminate in a finely dentate tip (Fig. 7) ..... *T. curvus*, (p. 228)
3. Without palpal features as given above ..... 4
4. Palp: ventral retrolateral tibial apophysis strongly chitinized and distally knobbed, the dorsal retrolateral apophysis a sharply pointed spine; near anterior margin of bulb the embolus turns toward base and then passes to retrolateral side and extends nearly to tip of cymbium as a long slender filament (Fig. 13) ..... *T. morosus*, (p. 235)
4. Palp: with a pair of long slender retrolateral apophyses almost meeting distally, and with a hook attached near base of shorter apophysis;

deeply grooved embolus makes a loop near distal margin of bulb and a second loop near base of bulb and continues as a fine filament to distal end of cymbium (Fig. 25) ..... *T. productus*, (p. 249)

5. Species with at least the dorsal retrolateral tibial apophysis elongated and well developed ..... 6
5. Species with retrolateral tibial apophyses less well developed; either with but one apophysis or with two shorter and poorly developed ..... 10
6. Palp: tibia with a short ventral retrolateral apophysis expanded distally, and a long slender curved retrolateral dorsal apophysis reaching to tip of cymbium and bifurcated distally; bulb with a basal hook; embolus curves along distal border of bulb and ends in a distal bifurcation (Fig. 1) ..... *T. aculeatus*, (p. 217)
6. Without palpal features as given above ..... 7
7. Palp: dorsal tibial apophysis bent at a right angle and extending nearly to distal border of bulb; bulb with a strongly chitinized ridge which runs, in general, obliquely across and terminates in a pointed spine on prolateral side; embolus arises on prolateral side near base, extends around margin to anterior border and there dilates and finally terminates in a slender spine which extends across to retrolateral margin of cymbium (Fig. 19) ..... *T. parki*, (p. 242)
7. Without palpal features as given above ..... 8
8. Palp: tibia with a pair of well developed retrolateral apophyses, the ventral one slender, well chitinized, somewhat hooked distally, the larger dorsal one much larger, flattened, extending beyond middle of cymbium; bulb with a prominent basal hook and two hooks near distal margin (Fig. 21) ..... *T. peregrinus*, (p. 245)
8. Without palpal features as given above ..... 9
9. Palp: two retrolateral apophyses well developed and well chitinized, ventral one a short hook, dorsal one long, slender, with denticles along its lateral border; bulb with a short stout basal spine, a central semilunate ridge, and with embolus probably encircling the bulb and terminating in a slender retrolateral spine (Fig. 23) ..... *T. probus*, (p. 247)
9. Palp: with two well developed and well chitinized retrolateral apophyses, the ventral one shorter and hook-like, the dorsal one long slender, with a prominent tooth about one third from base; bulb with a slender spine near middle on retrolateral side and a strongly ridged and chitinized area on retrolateral side near distal margin (Fig. 29) ..... *T. studiosus*, (p. 254)
10. Palp: tibia with a short blunt massive ventral retrolateral apophysis and a short, sharply pointed, dorsal retrolateral apophysis; bulb with two contiguous beak-like processes near distal border (Fig. 10) ..... *T. ineptus*, (p. 232)
10. Without palpal features as given above ..... 11
11. (Taken from the Cambridges). Palp: tibia with only a short ventral retrolateral apophysis, with the dorsal one represented by an enlarged "angle"; bulb with a single, somewhat broadly bifurcate process near anterior margin ..... *T. intentus*, (p. 234)
11. Without palpal features given above ..... 12

12. Palp: both tibial apophyses blunt and massive, each tipped by a short chitinized point; bulb with a central, lightly chitinized hook and embolus arising on prolateral side and extending to anterior margin where it makes a right angle turn and abruptly inflates and then terminates in a slender point (Fig. 16) ..... *T. mundulus*, (p. 239)
12. Without palpal features as given above ..... 13
13. (Taken from the Cambridges). Palp: tibia with two short blunt retrolateral apophyses, the ventral one turned retrolaterally; "bulb convoluted in the center, bearing a stout hammer-headed chitinous process directed backward and downward"; embolus apparently encircles the bulb and "curls in over the bulb from outer side" .. *T. pauper*, (p. 242)
13. Palp: tibia with two distal retrolateral apophyses, the ventral one a strongly chitinized, stout, blade-like spur, the dorsal one a blunt, rounded, strongly chitinized process concave toward the spur; bulb deeply excavated toward retrolateral side, with two basal spines, one contiguous to tibial spur, the other a distinct hook directed prolaterally and proximally; embolus extends around nearly three fourths of the margin of the bulb and terminates in a marked dilation which is abruptly truncated at its tip (Fig. 28) ..... *T. sigillatus*, (p. 252)

## Females

1. Epigynum, including spermathecae, definitely longer than wide ..... 2
1. Epigynum, including spermathecae, either about as wide as long or definitely wider than long ..... 6
2. Epigynal plate twice as long as wide, mildly narrowed in middle; with two large apertures at posterior end (Fig. 2) .. *T. bucculentus*, (p. 220)
2. Without epigynal features as given above ..... 3
3. Epigynal plate less than twice as long as wide; with a large anterior depression somewhat wider than long; with much elongated spermathecae extending nearly to genital groove (Fig. 3) ..... *T. cognatus*, (p. 222)
3. Without epigynal features as given above ..... 4
4. Epigynal plate with a transverse depression at anterior end, the depression with a pair of openings nearly two diameters of one of them apart; with three pairs of rounded spermathecal parts (Fig. 5) . *T. contortus*, (p. 224)
4. Without epigynal features as given above ..... 5
5. Epigynal plate with a pair of elongated openings less than a diameter of one of them apart, near anterior border; elongated and twisted spermathecae extend almost to genital groove (Fig. 8) ..... *T. curvus*, (p. 228)
5. Epigynal plate with a distinct small raised lip near anterior border and a large, somewhat triangular and heavily chitinized area behind the lip (Fig. 31) ..... *T. studiosus*, (p. 254)
6. (Taken from the Cambridges). Epigynal plate a somewhat oval area near genital groove; with a pair of rounded, nearly circular spermathecae within the area of the plate and less than the radius of one of them apart, and each with a pair of slender tubules arising on lateral side (Fig. 6) ..... *T. corruptus*, (p. 228)

6. Without epigynal features as given above ..... 7
7. (Taken from the Cambridges). Epigynal plate almost touching the genital groove, enclosing a pair of spiraloid concavities (Fig. 9) ..... *T. decens*, (p. 231)
7. Without epigynal features as given above ..... 8
8. Epigynal plate with an oval depression and a pair of oval spermathecae extending behind the depression almost to genital groove (Fig. 11) .... *T. ineptus*, (p. 232)
8. Without epigynal features as given above ..... 9
9. Epigynal plate with a short broad tongue between anterior ends of a pair of reniform spermathecae which reach nearly to genital groove; with a pair of small apertures on medial side of spermathecae anterior to their concavity (Fig. 12) ..... *T. intentus*, (p. 234)
9. Without epigynal features as given above ..... 10
10. Epigynal plate with a central scutiform area; a pair of apertures lateral to scutiform area; several coiled parts of spermathecae more or less surrounding central area (Fig. 15) ..... *T. morosus*, (p. 235)
10. Epigynal plate with a relatively large depression in anterior half; posterior border of depression irregular in outline; apertures lie within anterior depression (Fig. 18) ..... *T. mundulus*, (p. 239)

### TMARUS ACULEATUS spec. nov.

Figure 1

*Male holotype.* Total length from clypeus to tip of anal tubercle 4.832 mm. Carapace 1.696 mm. long; 1.440 mm. wide opposite second coxae where it is widest; .768 mm. tall and, therefore, about .53 as tall as wide; almost level from PME to beginning of steep posterior declivity opposite third coxae from which place declivity descends steeply and slightly arched to posterior border; a definite thoracic groove seems totally lacking; smooth posterior declivity without spines, but with a pair of long slender spines on each side and a transverse row of six similar ones lying at the top of the declivity; in front of these there is a transverse row of three spines and a single long one just posterior to PLE and three smaller spines in the interval between LE; ventral margin less fully rounded than in such species as *T. mundulus*.

*Eyes* Eight in two rows, all diurnal; tubercles around LE less prominent than in such species as *T. mundulus*, otherwise essentially the same; viewed from above, posterior row strongly recurved; viewed from in front, anterior row slightly procurved, measured by centers; central ocular quadrangle wider behind than in front in ratio of 19 : 14, wider behind than long in ratio of 19 : 17; posterior row occupies about three quarters of the total width of carapace at their level. Ratio of eyes AME : ALE : PME : PLE=3 : 6 : 4 : 5.5. AME separated from one another by eight thirds of their diameter, from

ALE by five halves of their diameter. PME separated from one another by nearly three times their diameter, from PLE by nearly three and a half times their diameter. Laterals separated by slightly more than twice the diameter of ALE. Clypeus quite strongly porrect. Width of clypeus equal to slightly more than five times the diameter of AME. Clypeus with a single slender spine near middle beneath interval between AME and a row of six slender spines along ventral margin.

*Chelicerae.* Slightly porrect; parallel; fairly robust; with a well defined basal boss; basal segment .644 mm. long; with numerous short bristles, especially along median margin, and two long slender spines near middle of anterior surface; fang short, robust at base and somewhat sinuous along outer margin; fang groove apparently without teeth.

*Maxillae.* Slightly convergent, extend far beyond tip of lip; basal half somewhat inflated, distal half slender; considerably depressed and constricted in middle; longer than wide in middle in ratio of 4 : 1; palp inserted into second fifth.

*Lip.* Very narrow at base, widest in middle; longer than wide in middle in ratio of 2 : 1. Sternal suture straight or slightly recurved.

*Sternum.* Broadly scutiform; longer than wide between second coxae, where it is widest, in ratio of 39 : 31; moderately well supplied with bristles and moderately convex; posterior end a blunt point not extended between fourth coxae which are separated by about five twelfths of their width.

*Legs.* 1243. Width of first patella at knee .244 mm., tibial index of first leg 9. Width of fourth patella at knee .200 mm., tibial index of fourth leg 14.

| | Femora | Patellae | Tibiae | Metatarsi | Tarsi | Totals |
|---|---|---|---|---|---|---|
| | | | (All measurements in millimeters) | | | |
| 1. | 2.176 | .704 | 1.856 | 1.344 | .960 | 7.040 |
| 2. | 2.176 | .736 | 1.792 | 1.344 | .896 | 6.944 |
| 3. | 1.216 | .416 | .960 | .576 | .544 | 3.712 |
| 4. | 1.344 | .448 | .960 | .576 | .576 | 3.904 |
| Palp | .544 | .256 | .128[1] | — | .768 | 1.696 |

*Spines.* First leg: femur dorsal 0–0–1–1–1–0, prolateral 1–1–1–1–0, retrolateral 0–0–1–1–0, ventral 0; patella dorsal 1(weak)–1; prolateral and retrolateral 0–1–0; tibia dorsal 0–1–0–1–0, prolateral and retrolateral 0–1–1–0, ventral 0–2(staggered)–2–0; metatarsus dorsal 0,

[1] Exclusive of apophysis; applies to all male palpal tibiae.

prolateral and retrolateral 0–1–0–0, ventral 1r–2–2–2(offset laterally). Second leg: essentially as in first. Third leg: femur dorsal 0–1–1–0, prolateral 1–1–1–0, retrolateral 0; patella only dorsal 1–1; tibia dorsal 0–1–1–0, prolateral and retrolateral 0–0–1–0, ventral 0–1p–0; metatarsus dorsal 0, prolateral and retrolateral 0–1–0, ventral 2–2–0. Fourth leg: essentially as in third.

*Palp.* Among the more complicated found in the genus. No. modifications except in tibia and tarsus. Body of tibia very short; with two strongly developed apophyses; ventral apophysis a short strongly chitinized process turned dorsolaterally and greatly expanded at its distal end; the dorsal apophysis is a very long, strongly chitinized process bifurcated at its distal end which extends to tip of tarsus. Bulb also rather complicated with a strongly chitinized hook at its base and a process arising near middle of prolateral side and curving around distal border nearly to middle of retrolateral wide where it also ends in a bifurcated tip (Fig. 1).

*Abdomen.* Long and slender; longer than wide in ratio of 16 : 5; widest about one third from base but nearly as wide at base; dorsum without tubercles, but with numerous long slender spines; six spinnerets as usual in the genus; colulus appears to be represented by a minute group of black bristles; tracheal spiracle with a distinct lip near base of anterior pair of spinerets; dorsal sigilla very obscure.

*Color in alcohol.* Carapace generally a medium amber color with bright reddish markings; a pair of small reddish spots lie between PME; a pair of short broad broken reddish stripes extend from PME and PLE to beginning of steep posterior declivity; with a reddish marginal stripe from opposite PLE to posterior border, very narrow at first but broadening posteriorly; with a few reddish dots on clypeus. Legs yellowsish, mottled with reddish especially along prolateral surfaces of first and second femora. Mouth parts and sternum generally yellowish. Abdomen generally yellowish, each dorsal spine arises from a reddish dot; across the dorsum extends four narrow irregular whitish bands, the first of which crosses about one third from base, the last one about one sixth from tip; behind the last whitish band is a short dark brownish band; anal tubercle and spinnerets dark at their tips; a narrow dark band nearly surrounds the bases of the spinnerets; venter yellowish, darkened laterally.

*Type locality.* Male holotype from C. Z. Biological Area, C. Z., July, 1939. Male paratypes from the following localities: C. Z. Biological Area, C. Z., July, 1936; Ft. Davis, C. Z., August, 1936; Arraijan, R. P., August, 1936; C. Z. Forest Reserve, C. Z., July, 1939.

### Tmarus bucculentus spec. nov.

(Figure 2)

*Female holotype.* Total length 7.168 mm. Carapace 2.944 mm. long; 2.432 mm. wide opposite second coxae where it is widest; 1.024 mm. tall and, therefore, about .41 as tall as wide; grooved beneath anterior row of eyes and with swollen and protruding clypeus; nearly level behind PME mid-dorsally to steep posterior declivity which begins two thirds of distance from PME to posterior border.

*Eyes.* Eight in two rows, all diurnal; LE on prominent tubercles; PME on small tubercles; AME very slightly raised from general surface; viewed from above, posterior row rather strongly recurved; viewed from in front, anterior row gently procurved, measured by centers; central ocular quadrangle wider behind than in front in ratio of 31 : 23, wider behind than long in ratio of 31 : 22; posterior row occupies nearly eleven fifteenths of total width of carapace at their level. Ratio of eyes AME : ALE : PME : PLE=3 : 6.5 : 4 : 5.5. AME separated from one another by nearly eight times the diameter of one of them, from ALE by nearly six times the diameter of one of them. PME separated from one another by nearly six times the diameter of one of them, from PLE by six and one half times the diameter of one of them. Laterals separated from one another by nearly three diameters of ALE. Clypeus very porrect; width of clypeus equal to about eleven diameters of AME. Clypeus with six fairly stout spines near its ventral border and three centrally placed in the middle beneath interval between AME.

*Chelicerae.* Porrect, robust, parallel and contiguous along medial surfaces. Basal segment 1.152 mm. long. No teeth along fang groove, but promargin with a soft membranous lobe along ventral border of which extends a row of numerous stiff black bristles. Entire anterior surface with numerous black bristles.

*Maxillae.* Slightly convergent; longer than wide in middle in ratio of nearly 4 : 1; somewhat constricted across the middle; longer than lip in ratio of nearly 3 : 2. Other features as usual in the genus from Panama.

*Lip.* Longer than wide at base in ratio of about 3 : 2; widest at middle; sternal suture straight or slightly procurved; with a cluster of stiff black terminal bristles and several spines on posterior surface.

*Sternum.* Almost oval; widest at middle opposite second coxae; longer than wide in ratio of about 22 : 15; not extended between fourth coxae which are nearly contiguous.

*Legs.* 1243. Width of first patella at "knee" .512 mm., tibial index of first leg 14. Width of fourth patella at "knee" .384 mm., tibial index of fourth leg 15.

| | Femora | Patellae | Tibiae | Metatarsi | Tarsi | Totals |
|---|---|---|---|---|---|---|
| | | | (All measurements in millimeters) | | | |
| 1. | 2.816 | 1.280 | 2.304 | 1.920 | 1.152 | 9.472 |
| 2. | 2.816 | 1.220 | 2.432 | 1.856 | 1.088 | 8.132 |
| 3. | 1.984 | .896 | 1.536 | .832 | .832 | 6.080 |
| 4. | 2.240 | .832 | 1.664 | .832 | .768 | 6.336 |

*Spines.* First leg: femur dorsal 0–0–1–0–1–0, prolateral 0–1–1–1–1–0, retrolateral 0–0–1–1–0; patella only dorsal 1–1, retrolateral 0–1–0; tibia dorsal 0–1–1–0, prolateral and retrolateral 0–1–1–0, ventral 0–2–2–0; metatarsus prolateral and retrolateral 0–1–0, ventral 2–2–0–2–2. Second leg: essentially as in first. Third leg: femur dorsal 0–1–1–0, prolateral 0–1–1–0; patella as in first; tibia dorsal 0–1–1–0, prolateral 0–1–1–0, retrolateral 0–0–1–0, ventral 0–2–0; metatarsus dorsal 0; prolateral 1–1, retrolateral 0–1–0, ventral 2–2–2(offset laterally). Fourth leg: femur dorsal 0–1–1–0, prolateral 0–0–1–0; patella and tibia as in third except tibia ventral 0–1p–0 on left and 1p–1p–0 on right; metatarsus prolateral 2–1–0, retrolateral 0–1–0, ventral 2–2–2. Palpal claw pectinate in a single row, with five or six teeth. Palpal spines: four long erect ventral spines in a row on femur with shorter ones on both sides of this row; numerous others on dorsal and lateral sides of more distal segments and especially on tarsus. Several trichobothria occur on palp, especially on dorsal surface of tibia.

*Abdomen.* Elongated and more or less cylindrical; longer than wide a little behind middle, where it is widest, in ratio of about 14 : 5; lateral sides nearly parallel; a transverse row of five spines on a slightly raised fold may indicate the site of a suppressed median dorsal tubercle; dorsal and dorsolateral areas with numerous long, slender, and apparently erectile spines. Otherwise essentially as usual in the genus from Panama.

*Epigynum.* Somewhat more than twice as long as wide; with a small anterior lip near the anterior boundary; with a pair of large apertures near posterior border (Fig. 2).

*Color in alcohol.* Carapace with a central, light reddish brown stripe as broad as entire ocular area and extending from anterior margin of clypeus to beginning of steep posterior declivity; this whole stripe is variegated with reddish brown and yellowish streaks and small dots; lateral sides yellowish white with two small reddish brown spots on each side a short distance dorsal to the narrow reddish brown ventral border. Sternum, chelicerae, lips, and palps generally light yellowish. Legs: generally light yellowish with many small reddish dots especially on prolateral surfaces of first two pairs; a narrow reddish dorsal

stripe on fourth patella and also in distal half of fourth tibia; these stripes are very faintly indicated on corresponding places on third legs. Abdomen: generally yellowish with small reddish spots lying at base of each of the numerous stout spines; beginning about three fifths from base there is a series of seven or eight narrow yellowish white irregular bars across dorsal area becoming shorter toward anal tubercle; dorso-laterally with a series of four or five long yellowish white stripes; ventro-lateral areas with small gray and reddish spots; venter a clear yellowish.

*Type locality.* Female holotype from Ft. Randolph, C. Z., August, 1936. One female paratype, C. Z. Biological Area, C. Z., August, 1936. One female paratype, Summit, C. Z., Oct., 1946 (L. H. Kraus). Loaned for study by Dr. W. J. Gertsch.

### Tmarus cognatus spec. nov.

Figure 3

*Female holotype.* Total length 3.20 mm. Carapace 1.408 mm. long, 1.28 mm. wide just behind second coxae where it is widest; .736 mm. tall and, therefore about .58 as tall as wide; very gently arched from PME to beginning of steep posterior declivity opposite third coxae; without a distinct thoracic groove; several long slender spines as well as numerous short hairs; fairly robust, but only moderately rounded from opposite PLE.

*Eyes.* Eight in two rows, all diurnal; LE on moderately prominent tubercles; PME only slightly raised from general surface; AME hardly raised at all; viewed from above, posterior row strongly recurved; viewed from in front, anterior row straight or slightly procurved measured by centers; central ocular quadrangle wider behind than in front in ratio of about 5 : 4, slightly wider behind than long; posterior row occupies about nine tenths of the width of the carapace at their level. Ratio of eyes AME : ALE : PME : PLE=2.5 : 4.75 : 3 : 4.5. AME separated from one another and from ALE by slightly less than three diameters of one of them. PME separated from one another by slightly more than ten thirds of their diameter, from PLE by nearly five times their diameter. LE separated from one another by slightly more than twice the diameter of PLE. Clypeus only moderately porrect. Height of clypeus (including membranous ventral margin) nearly equal to seven diameters of AME. Clypeus with a single long slender erect spine in middle of space beneath interval between AME, a row of six similar spines along ventral margin, two of these nearest median line very weak, next two lateral to these much more robust.

*Chelicerae.* Nearly vertical, essentially parallel; with a moderately well developed basal boss on each; moderately robust; basal segment .533 mm. long; fang short, robust at base, evenly curved; fang groove apparently without teeth.

*Maxillae.* Slightly convergent; extend far beyond tip of lip; basal half considerably inflated, distal half slender; palp inserted into middle third; longer than wide in middle in ratio of 23 : 7.

*Lip.* Longer than wide at base in ratio of about 2 : 1; widest at middle just beyond basal excavations; distal end slightly more than half as wide as base; with a moderately well developed scopula. Sternal suture straight.

*Sternum.* Broadly scutiform, quite convex; longer than wide in ratio of 11 : 9; widest between second coxae, but nearly as wide between first coxae; moderately well supplied with short bristles; not extended between fourth coxae which are separated by their width.

*Legs.* 1243. Width of first patella at "knee" .222 mm., tibial index of first leg 14. Width of fourth patella at "knee" .1887 mm., tibial index of fourth leg 18.

| | Femora | Patellae | Tibiae | Metatarsi | Tarsi | Totals |
|---|---|---|---|---|---|---|
| | | | (All measurements in millimeters) | | | |
| 1. | 1.216 | .576 | .960 | .704 | .576 | 4.032 |
| 2. | 1.216 | .448 | .960 | .736 | .608 | 3.968 |
| 3. | .768 | .390 | .580 | .416 | .416 | 2.570 |
| 4. | 1.024 | .390 | .640 | .416 | .416 | 2.886 |

*Spines.* First leg: femur dorsal and prolateral 0–0–1–1–0, retrolateral 0–0–0–1–0, ventral 0; patella only dorsal 1–1(both weak); tibia dorsal 0–1–0–1–0(judged by scars), prolateral and retrolateral 0–0–1–0, ventral 0–1p–2–0; metatarsus dorsal 0, prolateral 0, retrolateral 0–1–0, ventral 0–2–2–2. Second leg: femur as in first; patella apparently 0; tibia and metatarsus essentially as in first. Third leg: femur only dorsal 0–1–1–0 and prolateral 0–0–1–0; patella 0; tibia dorsal 0–1–0–1–0(both weak, scarcely more than bristles), prolateral and retrolateral 0–0–1–0, ventral 0; metatarsus dorsal 0, prolateral and retrolateral 0–1–0, ventral 0–2–0. Fourth leg: essentially as in third. Palpal claw and palpal trichobothria essentially as in *T. bucculentus* sp. nov.

*Abdomen.* Generally short and fairly broad; longer than wide in ratio of 13 : 10; widest about five thirteenths from posterior end and opposite the reduced posterior median tubercle; appears to have two much reduced median dorsal tubercles; the first is at base and the second is at level of widest part; anal tubercle a moderately prominent,

somewhat flattened cone; spinnerets as usual in the genus; colulus appears to be represented by a minute tuft of black bristles; tracheal tubercle near base of anterior spinnerets, obscure and without chitinous lip or tubercle.

*Epigynum.* Resembles that of *T. albolineatus* Keys. from Brazil. A moderately large central depression bounded laterally by well defined curved margins and divided by a broad septum lies at a considerable distance anterior to genital groove; a pair of small openings extend inward to notably coiled tubules and spermathecae (Fig. 3).

*Color in alcohol.* Legs generally yellowish with many small reddish, brownish, and whitish spots. First two pairs of legs darker along dorsal and prolateral surfaces. Palps yellowish with two small reddish spots on each front surface and a whitish streak along retrolateral edge on each side. Maxillae and lip yellowish. Carapace generally yellowish with a narrow median lanceolate reddish stripe behind PME, and two broad broken and irregular reddish brown stripes on each side extending from opposite the eye region to margin of steep posterior declivity. Sternum yellowish. Abdomen: dorsum highly variegated with reddish, yellowish white, and dark brown; near base there is a pair of dark irregular elongated spots diverging posteriorly; behind those are two smaller dark spots; at level of reduced posterior median tubercle is a narrow dark band which connects ventrally with a dark ventro-lateral stripe which broadens posteriorly and, much narrowed, passes anteriorly to base; venter entirely yellowish except as noted above.

*Type locality.* Female holotype and two female paratypes from C. Z. Forest Reserve, August, 1939.

### Tmarus contortus spec. nov.

Figures 4–5

*Male holotype.* Total length 2.816 mm. Carapace 1.248 mm. long; 1.152 mm. wide opposite second coxae where it is widest; .576 mm. tall and, therefore, .50 as tall as wide; from just behind PME descent is very gradual to beginning of steep posterior declivity opposite third coxae; posterior declivity more gradual than in many members of the genus; a definite thoracic groove is lacking; with numerous long slender spines especially in area between posterior eyes and smooth posterior declivity and at lateral sides of this region; generally not so inflated laterally as in many species of the genus and moderately rounded from opposite PLE to posterior border.

*Eyes.* Eight in two rows, all diurnal; ocular tubercles bearing LE moderately prominent, those bearing PME slightly developed, with

AME hardly raised at all; viewed from above, posterior row strongly recurved; viewed from in front, anterior row straight measured by centers; central ocular quadrangle wider behind than in front in ratio of 4 : 3, as wide behind as long; PLE extend somewhat beyond margins of carapace at their level. Ratio of eyes AME : ALE : PME : PLE= 2 : 4.5 : 2.5 : 4.25. AME separated from one another by 2.5 times their diameter, from ALE by three times their diameter. PME separated from one another by nearly three times their diameter, from PLE by about 5 times their diameter. Laterals separated from one another by a little less than three diameters of PLE. Height of clypeus equal to nearly seven times the diameter of AME. Clypeus provided with a single long slender spine in middle beneath interval between AME, and six others along ventral margin only two of which are well developed, others so small and weak as to be little more than bristles.

*Chelicerae.* Vertical; essentially parallel; of moderate size; with well developed basal boss; basal segment .400 mm. long; each with a single long slender spine in front about one third from base situated somewhat medial to middle line, together with several bristles; fang groove and fang as usual in the genus.

*Maxillae.* Moderately convergent; extend, as usual in the genus, far beyond distal end of lip; considerably enlarged in basal half, slender in distal half; longer than wide in middle (where considerable constriction occurs) in ratio of 17 : 6; palp inserted into basal half; with a small scopula at inner distal angle and a marginal serrula which extends far laterally.

*Lip.* About twice as long as wide at base; widest in middle; about two thirds as wide at truncated distal end as at base. Sternal suture straight.

*Sternum.* Broadly scutiform; nearly as wide as long; quite convex; widest between second coxae, but nearly as wide between first coxae; with a moderate supply of stiff bristles; posterior end bluntly rounded and not extended between fourth coxae which are separated by eight ninths of their width.

*Legs.* 1243. Width of first patella at "knee" .1554 mm., tibial index of first leg 7. Width of fourth patella at "knee" .1332 mm. tibial index of fourth leg 13.

| | Femora | Patellae | Tibiae | Metatarsi | Tarsi | Totals |
|---|---|---|---|---|---|---|
| | | | (All measurements in millimeters) | | | |
| 1. | 1.728 | .576 | 1.600 | 1.344 | .768 | 6.016 |
| 2. | 1.664 | .576 | 1.600 | 1.280 | .704 | 5.824 |
| 3. | .768 | .289 | .688 | .422 | .400 | 2.567 |
| 4. | .896 | .311 | .688 | .444 | .355 | 2.694 |
| Palp | .422 | .200 | .133 | — | .466 | 1.221 |

*Spines.* First leg: femur dorsal 0–1–1–0, prolateral and retrolateral 0–1–1–0, ventral 0; patella dorsal 1–0?, prolateral and retrolateral 0–1–0; tibia dorsal 0–1–0–1–0, prolateral and retrolateral 1–1–1–0, ventral 1p–2–2–0; metatarsus dorsal 0, prolateral and retrolateral 1–1–0–0, ventral 2–2–2. Second leg: femur as in first except prolateral 0–0–1–0; patella as in first except dorsal 1–0; tibia as in first except dorsal 0–0–1–0; metatarsus as in first. Third leg: femur only dorsal 0–1–1–0 and prolateral 0–0–1–0; patella 0(bristles replace spines); tibia dorsal 0–0–1–0, prolateral and retrolateral 0–1–1–0, ventral 0–1p–0; metatarsus dorsal 0, prolateral and retrolateral 0–1–0, ventral 0–2–0. Fourth leg: essentially as in third.

*Palp.* Complicated; modifications restricted to tibia and tarsus. Tibia: with two distal ventral apophyses and one dorsal distal retrolateral apophysis; the retrolateral ventral apophysis, a stout hook, is only one strongly chitinized, others short and inconspicuous Tarsus: deeply excavate at retrolateral basal corner; embolus arises near middle of anterior border of bulb, turns retrolaterally where it describes a complete circle perpendicular to long axis of bulb as a deeply grooved band; it then turns posteriorly and passes obliquely across the bulb and curves into a long loop with its tip turned ventrally (Fig. 4).

*Abdomen.* Slender, elongate, and pointed behind; longer than wide in ratio of 13 : 6; slightly the widest about one third from posterior end where tapering begins; well rounded at base; anal tubercle a fairly prominent, somewhat flattened cone; spinnerets as usual in the genus; colulus apparently represented by a tuft of black bristles; tracheal spiracle near base of anterior spinnerets, without chitinous lip or tubercle.

*Color in alcohol.* Carapace an amber yellowish with considerable yellowish white and red around eyes; space between PME reddish; a narrow reddish bar across the carapace extends about half way down the lateral sides and seems to be the most distinctive mark in this part of the body. Legs: generally yellowish; first two pairs finely dusted with brownish; femora one and two with a brownish prolateral stripe containing obscure reddish spots; legs three and four with a prolateral stripe extending over most of the femora, patellae, tibiae, and metatarsi, mostly brown on femora but reddish elsewhere. Mouth parts yellowish. Abdomen: generally yellowish with reddish and whitish markings, and nearly black marks especially on venter; dorsum with a pair of whitish bars which pass along lateral sides for a short distance; these whitish bars are contiguous posteriorly to a narrow reddish bar; behind these are three pairs of reddish and whitish dorsal bars, the reddish ones becoming shorter posteriorly with the last of these lying about one third from posterior end where a dark reddish narrow band

passes across the dorsum and down the lateral sides; the venter is a dusty yellowish in the middle and nearly black ventro-laterally and laterally; a narrow black band encircles the bases of the spinnerets but is incomplete dorsally.

*Female allotype.* Total length 4.608 mm. Carapace 1.664 mm. long; 1.472 mm. wide; .832 mm. tall and, therefore, nearly .57 as tall as wide; otherwise essentially as in male.

*Eyes.* Viewed from in front, anterior row slightly procurved measured by centers; central ocular quadrangle wider behind than in front in ratio of 17 : 13, slightly wider behind than long. Ratio of eyes AME : ALE : PME : PLE = 2.75 : 5.75 : 3 : 5. AME separated from one another by about three times the diameter of one of them, from ALE by slightly less than this. PME separated from one another by slightly less than twice the diameter of one of them, from PLE slightly more than twice the diameter of one of them. LE separated from one another by nearly three times the diameter of one of the PLE. Height of clypeus equal to about five times the diameter of AME if membranous ventral border is excluded. Otherwise as in male.

*Chelicerae.* Basal segment .64 mm. long. Otherwise essentially as in male.

*Maxillae, Lip,* and *Sternum.* Essentially as in male.

*Legs.* 1243. Width of first patella at "knee" .2664 mm., tibial index of first leg 11. Width of fourth patella at "knee" .1776 mm., tibial index of fourth leg 13.

| | Femora | Patellae | Tibiae | Metatarsi | Tarsi | Totals |
|---|---|---|---|---|---|---|
| | | | (All measurements in millimeters) | | | |
| 1. | 1.920 | .704 | 1.728 | 1.344 | .800 | 6.496 |
| 2. | 1.856 | .736 | 1.728 | 1.280 | .736 | 6.336 |
| 3. | .960 | .572 | .896 | .448 | .440 | 3.316 |
| 4. | 1.280 | .448 | .928 | .576 | .440[1] | 3.672 |

*Spines.* First leg: femur as in male except prolateral 0–0–1–1–1–0; patella apparently only retrolateral 0–1–0; tibia and metatarsus as in male. Second leg: femur dorsal 0–0–1–0–1–0, prolateral the same, retrolateral 0–0–1–1–0; patella as in first; tibia and metatarsus essentially as in male. Third leg: femur only dorsal 0–1–0–1–0; patella only dorsal 0–1; tibia only dorsal 0–1–0–0, prolateral 0–0–1–0, ventral 0–1p–0; metatarsus dorsal 0–1–0, elsewhere as in male. Fourth leg: essentially as in third.

*Abdomen.* Slightly damaged; generally more robust and less elongated than in male; longer than wide in ratio of 9 : 5; otherwise essentially as in male.

[1]Lacking in allotype; introduced from third leg.

*Epigynum.* Consists simply of a central transverse slit considerably anterior to genital groove with a small aperture at each end. The central slit appears to open into a pouch. Internally several coiled tubules and spermathecae are visible through the surface (Fig. 5).

*Color in alcohol.* Everywhere except on abdomen essentially as in male. Abdomen: with much less clearly developed pattern of cross bars than in male and with much more white on dorsum; ventrolaterally and laterally with less dark coloration.

*Type locality.* Male holotype, female allotype, together with one male paratype and three immature specimens from Madden Dam region in brush, C. Z., August, 1939.

## Tmarus corruptus O. P.-Cambridge, 1892

Figure 6

*T. mendax* O. P.-Cambridge, 1894
*T. corruptus* F. P.-Cambridge, 1900
*T. corruptus* Petrunkevitch, 1911
*T. corruptus* Petrunkevitch, 1925

Known only from the female from Mexico and Bugaba, Panama. It has not yet appeared in my collection and has not, to my knowledge, been collected since the time of the Cambridges.

## Tmarus curvus spec. nov.

Figures 7–8

*Male holotype.* Total length 2.304 mm. Carapace 1.024 mm. long; .960 mm. wide opposite second coxae whre it is widest; .512 mm. tall and, therefore, about .53 as tall as wide; nearly flat behind PME to steep posterior declivity which is quite abrupt; without any definite thoracic groove; ventral margin well rounded from opposite PLE to posterior margin which is only slightly concave.

*Eyes.* Eight in two rows, all diurnal; LE on prominent tubercles; PME slightly raised; AME hardly raised from general surface; viewed from above, posterior row strongly recurved; viewed from in front, anterior row slightly procurved, measured by their centers; central ocular quadrangle wider behind than in front in ratio of 11.5 : 9, slightly wider behind than long; posterior row occupies slightly less than full width of carapace at their level. Ratio of eyes AME : ALE : PME : PLE = 2 : 4 : 2.5 : 3.75. AME separated from one another by nearly three diameters of one of them, from ALE by five halves of the diameter of one of them. PME separated from one another by nearly

three diameters of one of them, from PLE by four diameters of one of them. Laterals separated from one another by two diameters of ALE. Clypeus only slightly porrect. Height of clypeus equal to nine halves of the diameter of AME. Clypeus with short bristles and probably, in life, with long slender spines as described for *T. contortus* sp. nov.

*Chelicerae.* Basal segment .4218 mm. long. Otherwise essentially as in T. contortus sp. nov.

*Maxillae.* Longer than wide at middle constriction in ratio of 17 : 5. Otherwise as described for *T. contortus* sp. nov.

*Lip.* Longer than wide at base in ratio of about 11 : 5; about four fifths as wide at truncated distal border as at base; widest in middle. Sternal suture straight.

*Sternum.* Posterior coxae separated by their full width. Otherwise essentially as described for *T. contortus* sp. nov.

*Legs.* 1243. Width of first patella at "knee" .1332 mm., tibial index of first leg 9. Width of fourth patella at "knee" .1110 mm., tibial index of fourth leg 13.

| | Femora | Patellae | Tibiae | Metatarsi | Tarsi | Totals |
|---|---|---|---|---|---|---|
| | | | (All measurements in millimeters) | | | |
| 1. | 1.152 | .416 | 1.024 | .832 | .576 | 4.000 |
| 2. | 1.184 | .416 | 1.024 | .765 | .576 | 3.965 |
| 3. | .640 | .320 | .544 | .320 | .384 | 2.208 |
| 4. | .832 | .320 | .572 | .384 | .384 | 2.492 |
| Palp | .320 | .1776 | .111 | — | .400 | 1.009 |

*Spines.* First leg: femur dorsal 0–0–1–0–1–0 on right, 0–1–1–1–1–0 on left, prolateral and retrolateral 0–0–1–1–0; patella only dorsal 0–1, tibia dorsal 0–1–0–1–0, prolateral and retrolateral 0–1–1–0, ventral 0–1p–2–0; metatarsus dorsal 0, prolateral 0, retrolateral 0–1–0, ventral 2–2–2. Second leg: essentially as in first. Third leg: femur dorsal 0–1–0–1–0 and prolateral 0–0–1–0; patella only dorsal 0–1 (weak); tibia dorsal 0–0–1–0, prolateral and retrolateral 0–1–0, ventral 0; metatarsus only prolateral and retrolateral 0–0–1–0. Fourth leg: essentially as in third.

*Palp.* Complicated; only tibia and tarsus modified. Tibia deeply excavated distally on retrolateral side; with a well developed and strongly chitinized apophysis just ventral to excavation. Tarsus with a strongly chitinized bulb; embolus arises on prolateral side near base, curves along prolateral side of bulb to anterior border where it describes a complete circle and then passes to near middle of retrolateral side in a somewhat undulating fashion (Fig. 7).

*Abdomen.* Elongate ovate, pointed behind; longer than wide in ratio of 20 : 13; slightly widest about three fifths from base and tapered from this point to anal tubercle; with no indications of dorsal tubercles. Otherwise essentially as in *T. contortus* sp. nov.

*Color in alcohol.* Carapace generally amber yellowish, roughly divided into seven stripes, four dark and three light; beginning on each side at PLE a fairly broad short brownish stripe extends backward onto posterior declivity; beginning beneath PLE at margin on each side another brownish stripe extends back to posterior declivity, at first narrow but soon becoming broad; all of these are irregular and broken. Mouth parts and sternum yellowish. Legs: generally yellowish; first two pairs with considerable dusty brown color; femora of first and second pairs with a conspicuous broad brownish prolateral stripe; patellae and metatarsi of first two pairs much darkened at distal ends; all segments of first two pairs with yellowish white patches on prolateral surfaces; third and fourth legs with scattered pale brownish and reddish spots. Abdomen: dorsally with a variegated pattern difficult to describe adequately; most distinctive features seem to be a pair of basal irregular dark spots separated by a small median dorsal white spot; behind these spots are two pairs of somewhat indefinite narrow white bars separated by darker areas; extending across the widest part is an irregular black narrow bar which extends laterally to connect with broad dark lateral and ventro-lateral stripes; venter almost entirely yellowish.

*Female allotype.* Total length 3.296 mm. Carapace 1.376 mm. long; 1.28 mm. wide; .640 mm. tall and, therefore, .50 as tall as wide; otherwise essentially as in male.

*Eyes.* Central ocular quadrangle wider behind than in front in ratio of 4 : 3; wider behind than long in ratio of 8 : 7. Ratio of eyes AME : ALE : PME : PLE=2.5 : 5 : 2.75 : 4.25. AME separated from one another by nearly three times the diameter of one of them, from ALE by slightly less than this. PME separated from one another by slightly more than three and one half times the diameter of one of them, from PLE by nearly four and one half times the diameter of one of them. Laterals separated from one another by a little more than two and one half times the diameter of PLE. Height of clypeus equal to six times the diameter of AME. Otherwise essentially as in male.

*Chelicerae.* Basal segment .555 mm. long. Otherwise essentially as in male.

*Maxillae, Lip* and *Sternum.* Essentially as in male.

*Legs.* 1243. Width of first patella at "knee" .2442 mm., tibial index of first leg 17. Width of fourth patella at "knee" .1998 mm., tibial index of fourth leg 21.

| | Femora | Patellae | Tibiae | Metatarsi | Tarsi | Totals |
|---|---|---|---|---|---|---|
| | | | (All measurements in millimeters) | | | |
| 1. | 1.152 | .512 | .896 | .704 | .576 | 3.840 |
| 2. | 1.088 | .512 | .928 | .704 | .576 | 3.808 |
| 3. | .704 | .320 | .608 | .384 | .416 | 2.432 |
| 4. | .960 | .320 | .640 | .448 | .416 | 2.784 |

*Spines.* First leg: femur dorsal, prolateral, and retrolateral 0–1–1–0; patella 0; tibia only prolateral and retrolateral 0–0–1–0, ventral 0–2–2–0; metatarsus only ventral 0–2–2–2. Second leg: essentially as in first. Third leg: femur only dorsal 0–1–1–0; patella 0 (or dorsal 1–1, hardly more than bristles); tibia only prolateral and retrolateral 0–1–0; metatarsus only prolateral and retrolateral 0–1–0. Fourth leg: essentially as in third except metatarsus ventral 0–0–2.

*Abdomen.* More robust than in male; longer than wide in ratio of 10 : 7. Otherwise essentially as in male except for sexual features.

*Epigynum.* Simple; with two openings at considerable distance from posterior border and separated from one another by less than the width of one of them. These apertures open internally to relatively large tubules or spermathecae which extend nearly to posterior border (Fig. 8).

*Color in alcohol.* Color pattern in general like that of male but not so well delineated. Legs more definitely spotted with red and without the dark prolateral stripes found in male.

*Type locality.* Male holotype and female allotype from Canal Zone Biological Area, C. Z , August, 1936. Paratypes of both sexes from the following localities: C. Z. Biological Area, C. Z., August, 1936, July, 1939; Madden Dam region. C. Z., August, 1936; Porto Bello, R. P., August, 1936; Arraijan, R. P., August, 1936; C. Z. Forest Reserve, C. Z , July, August, 1939.

### Tmarus decens O. P.-Cambridge, 1892

Figure 9

*T. decens* F. P.-Cambridge, 1900
*T. decens* Petrunkevitch, 1911
*T. decens* Petrunkevitch, 1925

Known only from the female from Bugaba, Panama. It has not appeared in my collections and, apparently, has not been taken since the original collection studied by the Cambridges.

## Tmarus ineptus O. P.-Cambridge, 1892

Figures 10–11

*T. ineptus* F. P.-Cambridge, 1900
*T. ineptus* Petrunkevitch, 1911
*T. ineptus* Petrunkevitch, 1925
*T. intentus* Banks, 1929

The Cambridges had only females. Males are fairly numerous in my collection. The male allotype is here described in detail in accord with my usual method.

*Allotype male.* Total length (exclusive of the chelicerae) 3.13 mm. Carapace 1.248 mm. long; 1.28 mm. wide opposite second coxae where it is widest; .576 mm. tall and, therefore, about .45 as tall as wide; very gently arched behind PME to nearly opposite third coxae where steep posterior declivity begins and continues with a steeply arched decline to posterior border which is only gently notched; without a distinct thoracic groove; smooth posterior declivity without spines; a procurved row of three long slender spines just lateral and posterior to PME, a slightly recurved row of three somewhat more robust long slender spines a little more than one half the distance from first row to beginning of posterior declivity where another row of four long slender spines occurs; lateral to the lower part of the posterior declivity occur three more of these long spines on each side; ventral margin well rounded from below intertubercular space separating LE to posterior border.

*Eyes.* Eight in two rows, all diurnal; LE on large prominent tubercles, PME on small tubercles, AME hardly raised from general surface; viewed from above, posterior row strongly recurved; central ocular quadrangle wider behind than in front in ratio of 3 : 2, slightly wider behind than long; posterior row occupies seven tenths of width of carapace at that level. Ratio of eyes AME : ALE : PME : PLE= 2.3 : 4.5 : 3 : 4. AME separated from one another by nearly two and one half times the diameter of one of them, from ALE by three times the diameter of one of them. PME separated from one another by three times the diameter of one of them, from PLE by nearly four times the diameter of one of them. LE separated from one another by a little more than twice the diameter of ALE. Clypeus only moderately porrect. Height of clypeus equal to about five and one half times the diameter of AME. Clypeus decorated by a single long slender spine well beneath interval between AME and a row of four similar bristles near margin beneath ALE. A chitinous nodule at outer ventral corner of clypeus.

*Chelicerae.* Nearly vertical and parallel; apparently with only an obscure basal boss; moderately robust; basal segment .448 mm. long; fang short, robust at base, regularly curved; fang groove apparently without teeth.

*Maxillae.* Moderately convergent; extend far beyond tip of lip; basal half rather inflated and definitely convergent so that lip appears narrow at base; palp inserted into middle third; more than three times as long as wide at narrowest place, just beyond middle.

*Lip.* Longer than wide at base in ratio of about 3 : 1; widest near middle.

*Sternum.* Broadly scutiform; longer than wide in ratio of about 8 : 7; moderately well supplied with bristles, the most anterior of which are spiniform; widest between second coxae, but nearly as wide between first coxae; not extended between fourth coxae which are separated by about two thirds of the width of one of them.

*Legs.* 1243. Width of first patella at "knee" .222 mm., tibial index of first leg 8. Width of fourth patella at "knee" .1554 mm., tibial index of fourth leg 13.

| | Femora | Patellae | Tibiae | Metatarsi | Tarsi | Totals |
|---|---|---|---|---|---|---|
| | (All measurements in millimeters) | | | | | |
| 1. | 2.240 | .704 | 2.048 | 1.728 | .832 | 7.552 |
| 2. | 2.176 | .640 | 1.856 | 1.408 | .832 | 6.912 |
| 3. | .970 | .320 | .896 | .448 | .448 | 3.082 |
| 4. | 1.088 | .384 | .832 | .480 | .448 | 3.232 |
| Palp | .444 | .199 | .155 | — | .422 | 1.220 |

*Spines.* First leg: femur dorsal 0–0–1–1–1–1–0, prolateral 0–0–1–1–1–0, retrolateral 0–0–1–1–0, ventral 0; patella dorsal 1–1, prolateral 0–1–0 on left and 0–1–1–0 on right; tibia dorsal 0–1–0–1–0, prolateral 0–1–0–1–1–0, , retrolateral 0–1–1–1–0, ventral 0–2–2–2–0; metatarsus dorsal 0, prolateral and retrolateral 0–1–1–0, ventral with seven spines irregularly distributed. Second leg: essentially as in first with few variations. Third leg: femur dorsal 0–1–1–1–0, prolateral 0–0–1–0, ventral 0–0–1p–0; patella only dorsal 1–1; tibia dorsal and prolateral 0–1–1–0, retrolateral 0–0–1–0, ventral only 0–1p–0; metatarsus prolateral and retrolateral 1–1–1(first and last weak), ventral 0–2–1r–0. Fourth leg: femur and patella essentially as in third; tibia dorsal, prolateral, and retrolateral 0–1–1–0, ventral 0; metatarsus dorsal 0, prolateral and retrolateral 0–1–0, ventral 0–1p–0. Palpal spines: several very long slender dorsal spines on patella and tibia with a single one near base of tarsus.

*Palp.* Among the simplest found in the genus; tibia with a short, weakly developed, membranous, retrolateral apophysis having a short,

strongly chitinized tubercle near its base. Tarsus: bulb simple, nearly as broad as long; with a short, apparently bifurcate spine emerging from a broad anterior opening (Fig. 10).

*Abdomen.* Elongate; longer than wide in ratio of 30 : 13; blunt at base; slightly the widest just anterior to much reduced median dorsal tubercle; tapered from this widest region to anal tubercle; quite spinose dorsally with a group of more or less erect dorsal and somewhat more robust spines at base; about one third from base there is a pair of robust erect spines, each on a small tubercle; with four dorsal sigilla quite plainly indicated in anterior half; six spinnerets compactly grouped with posterior pair the longest, but with none greatly elongated. Colulus not visible. Tracheal spiracle near base of spinnerets with a ventral, slightly chitinous lip.

*Color in alcohol.* Legs: generally yellowish, lighter below; first and second femora and patellae mottled with brown prolaterally and, less so, retrolaterally. Mouth parts as in legs except mottled areas; chelicerae mottled with brown in front, palpal femora retrolaterally. Carapace: with a broad light stripe through middle from opposite ALE to posterior border, narrowed at beginning of steep posterior declivity and near posterior margin; elsewhere darker with irregular brown stripes and flecks. Sternum yellowish. Abdomen: dorsal area whitish with red dots, especially at bases of spines, many light irregular pinkish lines and small brownish spots; a nearly black spot at each anterior dorsal corner; with several lateral narrow broken alternate whitish and brownish stripes; ventro-laterally yellowish white with central region of venter yellowish with narrow light brownish stripes; a black patch covers area of genital furrow.

*Type locality.* Male allotype from C. Z. Biological Area, C. Z., July, 1939. Numerous male paratypes and females from the following localities: C. Z. Biological Area; June–July, 1934; July 1943–March 1944 (Berlese funnel, Dr. Zetek); Ft. Randolph, C. Z., August, 1936; El Valle, R. P., July, 1936; Balboa, C. Z., August, 1936; Porto Bello, R. P., August, 1936; Arraijan, R. P., August, 1936; Madden Dam region, Chilibre, Frijoles, Ft. Sherman, C. Z., August, 1939.

### Tmarus intentus O. P.-Cambridge, 1892

Figure 12

*T. intentus* F. P.-Cambridge, 1900
*T. intentus* Petrunkevitch, 1911
*T. intentus* Petrunkevitch, 1925

The Cambridges had what they considered the male from Guatemala and the female from Panama. I have two females from the Canal Zone

Biological Area, July, 1936 which I believe belong to this species. The male has not been taken so far as I know, since the original collection in Guatemala. Figure 12 is drawn from one of my specimens. I have already indicated that I consider Mr. Banks' record of *T. intentus* from Ft. Davis, C. Z. as due to a misidentification of *T. ineptus*.

### TMARUS MOROSUS spec. nov.

Figures 13–15

*Male holotype.* Total length 3.264 mm. Carapace 1.236 mm. long; 1.152 mm. wide opposite second coxae where it is widest; .608 mm. tall and, therefore, about .53 as tall as wide; descent behind PME gentle to steep posterior declivity which descends quite abruptly to posterior border; without a definite thoracic groove; with the usual long slender spines arranged along margin of smooth posterior declivity and in three rows behind posterior row of eyes; regularly and quite fully rounded along ventral margin from constriction opposite insertion of palps to posterior border.

*Eyes.* Eight in two rows, all diurnal; LE on prominent tubercles; confluent; PME on separated low tubercles; AME very slightly raised from general surface; viewed from above, posterior row strongly recurved; viewed from in front, anterior row straight or slightly procurved measured by centers; central ocular quadrangle wider behind than in front in ratio of 12 : 7, almost exactly as long as wide behind; posterior row occupies six sevenths of width of carapace at their level. Ratio of eyes AME : ALE : PME : PLE = 2 : 5 : 3 : 5. AME separated from one another by two diameters of one of them, from ALE by five halves of the diameters of one of them. PME separated from one another by slightly more than seven thirds of the diameter of one of them, from PLE by eleven thirds of the diameter of one of them. Laterals separated from one another by nearly two diameters of one of them. Clypeus moderately porrect, less so than in female; with seven long slender spines near ventral border. Height of clypeus equal to six diameters of AME (including the membranous ventral border).

*Chelicerae.* Slightly porrect, much less so than in female; parallel; somewhat convex near middle in front; with several long slender spines in front in medial half; with well developed basal boss from which a chitinous ridge extends to middle of lateral side. Other features as usual in the genus.

*Maxillae.* Slightly convergent; longer than lip in ratio of 20 : 13; longer than wide at middle constriction in ratio of 10 : 3; robust in basal half, slender in distal half; with a fairly well developed scopula

at inner distal angle and with a serrula which extends nearly to middle constriction.

*Lip.* Longer than wide at base in ratio of 13 : 5; widest in middle; distal end rounded, with a tuft of dark stiff bristles. Sternal suture straight.

*Sternum.* Broadly scutiform; longer than wide in ratio of 16 : 13; quite convex; widest between second coxae. but nearly as wide between first coxae; posterior end bluntly pointed and not extended between fourth coxae which are separated by three fifths of their width.

*Legs.* 123=4. Width of first patella at "knee".1998 mm., tibial index of first leg 7. Width of fourth patella at "knee" .1554 mm., tibial index of fourth leg 12.

| | Femora | Patellae | Tibiae | Metatarsi | Tarsi | Totals |
|---|---|---|---|---|---|---|
| | | | (All measurements in millimeters) | | | |
| 1. | 2.432 | .736 | 2.304 | 1.984 | .960 | 8.416 |
| 2. | 2.272 | .672 | 1.984 | 1.728 | .864 | 7.520 |
| 3. | 1.024 | .416 | .960 | .512 | .512 | 3.424 |
| 4. | 1.152 | .416 | .896 | .512 | .448 | 3.424 |
| Palp | .422 | .222 | .167 | — | .511 | 1.322 |

*Spines.* First leg: femur dorsal 0–0–1–1–0, prolateral 0–1–1–1–0, retrolateral 0–0–0–1–0; patella 0(all replaced by bristles); tibia dorsal 0–1–0–1–0, prolateral and retrolateral 0–1–1–1–0, ventral 0–2–2–0; metatarsus dorsal 0, prolateral and retrolateral 0–1–0, ventral 0–2–2 (all irregular in placement)–0. Second leg: essentially as in first. Third leg: femur only dorsal 0–1–1–0; elsewhere 0. Fourth leg: essentially as in third except metatarsus ventral 0–1p–0.

*Palp.* Moderately complicated; only tibia and tarsus modified; tibia with two retrolateral apophyses, the ventral one a strongly chitinized, curved, and knobbed process, the dorsal one a long, moderately robust spur. Tarsus: with an embolus which becomes free near anterior margin of bulb, turns toward base and extends onto retrolateral side of cymbium as a long slender and somewhat sinuous thread (Figs. 13–14).

*Abdomen.* Elongated; longer than wide in ratio of 33 : 12; blunt at base; nearly parallel-sided back to within about one third of distal end from where it tapers to anal tubercle; a fairly conspicuous median dorsal tubercle projecting posteriorly just a little anterior to anal tubercle to make a small "caudal" appendage, less pronounced than in female; midway between base and median tubercle are two small incipient dorsal tubercles each bearing a long slender spine; other features as usual in the genus.

*Color in alcohol.* Essentially as described for the female, but less distinct than in that sex.

*Female allotype.* Total length 5.312 mm. Carapace 1.984 mm. long, 1.632 mm. wide opposite posterior border of second coxae; .768 mm. tall and, therefore, about .47 as tall as wide; nearly level behind PME to steep posterior declivity which descends steeply to moderately concave posterior border; without a definite thoracic groove; with the usual dorsal spines; ventral margin slightly constricted opposite second coxae as well as more deeply at lateral sides of clypeus; only moderately rounded laterally.

*Eyes.* Eight in two rows, all diurnal; LE on prominent tubercles; PME considerably raised on separate small tubercles; AME hardly raised from general surface; viewed from above, posterior row strongly recurved; viewed from in front, anterior row slightly procurved measured by centers; central ocular quadrangle wider behind than in front in ratio of 17 : 11, wider behind than long in ratio of 17 : 16; posterior row occupies about five sixths of width of carapace beneath PLE. Ratio of eyes AME : ALE : PME : PLE = 2.5 : 6.5 : 3 : 6. AME separated from one another by five halves of the diameter of one of them, from ALE by three diameters of one of them. PME separated from one another by seven halves of the diameter of one of them, from PLE by nearly five times the diameter of one of them. Laterals separated from one another by eleven sixths of the diameter of PLE. Clypeus very porrect, thus extending the length of carapace; with numerous short bristles and seven long slender spines near ventral margin, the middle one set lower down than usual. Width of clypeus, including membranous ventral border, equal to seven diameters of AME.

*Chelicerae.* Very porrect; parallel; robust; with well developed basal boss and a ridge from boss two thirds to distal end; with a group of fourteen or fifteen short spines arranged along median third of front surface; basal segment .733 mm. long. Fang and fang groove as usual in the genus.

*Maxillae.* Almost parallel; longer than lip in ratio of 3 : 2; longer than wide at middle constriction in ratio of nearly 10 : 3; moderately inflated in basal half, slender in distal half; with a fairly well developed scopula at inner distal angle and with a serrula which extends far over the lateral border.

*Lip.* Longer than wide at base in ratio of 2 : 1; widest in middle; about half as wide at tip as at base. Sternal suture slightly procurved.

*Sternum.* More elongate than usual in the genus from Panama; longer than wide in ratio of 47 : 35; widest between second coxae;

moderately convex; with a well developed covering of stiff bristles; posterior end pointed and not extended between fourth coxae which are separated by about one third of the width of one of them.

*Legs.* 1243. Width of first patella at "knee" .3552 mm., tibial index of first leg 10. Width of fourth patella at "knee" .1998 mm., tibial index of fourth leg 11.

| | Femora | Patellae | Tibiae | Metatarsi | Tarsi | Totals |
|---|---|---|---|---|---|---|
| | (All measurements in millimeters) | | | | | |
| 1. | 2.944 | 1.024 | 2.496 | 1.984 | 1.152 | 9.600 |
| 2. | 2.720 | 1.024 | 2.368 | 1.856 | 1.088 | 9.056 |
| 3. | 1.344 | .544 | 1.280 | .640 | .640 | 4.448 |
| 4. | 1.600 | .544 | 1.280 | .672 | .640 | 4.736 |

*Spines.* First leg: femur dorsal 0–0–1–1–0, prolateral 0–1–1–1–0, retrolateral 0–0–1–1–0, ventral 0; patella dorsal 1–1(both little more than bristles), prolateral 0–1–0; tibia dorsal 0–1–0–0–1–0, prolateral 0–1–1–1–0, retrolateral 0–0–1–1–0, ventral 0–1p–2–2(bristles); metatarsus dorsal 0, prolateral and retrolateral 0–1–0, ventral 0–1p–2–0–2–1p–2. Second leg: femur, patella, and tibia as in first except patella prolateral 0 and tibia prolateral 0–0–1–1–0; metatarsus prolateral and retrolateral 0–1–0, ventral 0–2–2–2. Third leg: femur only dorsal 0–1–1–0 and prolateral 0–0–1–0; patella dorsal 1–1, prolateral 0–1–0(all patellar spines little more than bristles); tibia dorsal 1 (weak)–0–1–0, prolateral and retrolateral 0–1–0, ventral 0–1p–0; metatarsus dorsal 0, prolateral and retrolateral 0–1–0, ventral 0–2–0. Fourth leg: femur and tibia as in third; patella prolateral 0, retrolateral 0–1–0; metatarsus prolateral 0–1–1, retrolateral 0–1–0, ventral 0–2–1p. Palpal spines: numerous on last three segments but without definite or at least regular placement. Palpal claw pectinate in a single row of seven or eight slender teeth.

*Abdomen.* Elongated; longer than wide in ratio of 25 : 11; with a conspicuous median dorsal tubercle just above the spinnerets, thus forming a distinct "caudal appendage"; blunt and squarely truncated at base; other features as usual in the genus.

*Epigynum.* Complicated; a short distance in front of the posterior border are two black dots about seven diameters of one of them apart; somewhat anterior to the dots there is a scutiform area with several ridges, pockets, and apertures forming a design difficult to describe adequately; several internal tubules showing through the surface layer add to the complexity of the design (Fig. 15).

*Color in alcohol.* Carapace: highly variegated with brownish and whitish streaks radiating from the top of the steep posterior declivity; also many fine reddish dots generally distributed; a thin red line runs

laterally just dorsal to ventral margin. Legs: generally much dotted and spotted with red and brown; first and second femora with a broad stripe throughout on prolateral and ventral surfaces with prolateral half brownish and ventral half reddish. Lip, chelicerae, maxillae, and sternum all yellowish with reddish dots and streaks. Abdomen: with the most distinctive color features; a distinct dorsal folium throughout the length of the abdomen, lighter through the middle but darker along the lateral sides; all the way around there is a whitish stripe contiguous to brownish border of the folium; lateral sides striated by narrow alternate and more or less broken brownish and whitish stripes; venter light colored with a somewhat darker stripe through the center with a lighter stripe on each side and a longitudinal row of brownish dots lateral to those.

*Type locality.* Male holotype from C. Z. Biological Area, C. Z., June, 1936; female allotype from Madden Dam region, from low bushes, August, 1939. Several male and female paratypes from the following localities: C. Z. Biological Area, C. Z. Forest Reserve, Chilibre, C. Z., and Fort Sherman, C. Z., August, 1939.

### Tmarus mundulus O. P.-Cambridge, 1892

Figures 16–18

*T. mundulus* F. P.-Cambridge, 1900
*T. mundulus* Petrunkevitch, 1911
*T. mundulus* Petrunkevitch, 1925

The Cambridges had only females and the species has not been reported since their time, so far as I know. The species appears to be common in the regions where I have worked in Panama and both sexes are numerous in my collection. The male allotype has been selected and is herewith described in detail.

*Male allotype.* Total length 2.688 mm. from clypeus to tip of anal tubercle. Carapace 1.152 mm. long; 1.152 mm. wide opposite second coxae where it is widest; .512 mm. tall and, therefore, about .44 as tall as wide; tallest in region of PLE; arched essentially as in *T. ineptus*; thoracic groove lacking; smooth posterior steep declivity without spines but with a row of three long curved slender spines on each side of posterior declivity; with a transverse row of the same type of spines at top of posterior declivity; with a row of three similar spines on each side behind PLE meeting at top of posterior declivity; with a few other spines less definitely placed; ventral margin constricted sharply just lateral to insertion of chelicerae from which place it is well rounded to posterior surface.

*Eyes.* Eight in two rows, all diurnal; LE on large, rather prominent tubercles well separated by a deep groove; PME on smaller tubercles;

AME hardly raised from general surface; viewed from above, posterior row strongly recurved; viewed from in front, anterior row slightly recurved measured by centers; central ocular quadrangle wider behind than in front in ratio of about 13 : 8, slightly longer than wide behind; posterior row somewhat wider than carapace below PLE because of extension of ocular tubercles. Ratio of eyes AME : ALE : PME : PLE=2.3 : 4.3 : 3 : 4. AME separated from one another by nearly twice their diameter, from ALE by nearly 2.2 times their diameter. PME separated from one another by a little more than twice their diameter, from PLE by three and one half times their diameter. Laterals separated from one another by a little more than twice the diameter of PLE. Clypeus only moderately porrect. Height of clypeus equal to a little more than four diameters of AME. Clypeus decorated only with very slender spines most of which have been broken off by handling.

*Chelicerae.* Nearly vertical, only slightly porrect; essentially parallel; with a moderately well developed basal boss; moderately robust; basal segment .488 mm. long; fang moderately robust at base, short, evenly curved; fang groove apparently without teeth but with a moderately well developed scopula along promargin.

*Maxillae.* Slightly convergent with inclination in distal halves; somewhat dilated in basal halves contiguous to lip; palp inserted into middle third; extends far beyond tip of lip; widest at insertion of palp where it is nearly five halves as wide as at constriction just distal to place of attachment; with well developed scopula at distal margin and medial to this region.

*Lip.* Longer than wide at base in ratio of nearly 2 : 1; widest about one third from base; distal end well rounded and moderately tapered.

*Sternum.* Broadly scutiform; moderately convex; widest between second coxae where it is slightly wider than long; nearly as wide between first coxae; posterior end bluntly rounded and not extended between fourth coxae which are separated by their width. Sternal suture straight.

*Legs.* 2143. Width of first patella at "knee" .1998 mm., tibial index of first leg 12. Width of fourth patella at "knee" .1554 mm., tibial index of fourth leg 15.

| | Femora | Patellae | Tibiae | Metatarsi | Tarsi | Totals |
|---|---|---|---|---|---|---|
| | | | (All measurements in millimeters) | | | |
| 1. | 1.408 | .448 | 1.240 | 1.088 | .704 | 3.772 |
| 2. | 1.536 | .512 | 1.350 | 1.088 | .704 | 4.190 |
| 3. | .832 | .384 | .640 | .448 | .448 | 2.752 |
| 4. | 1.024 | .320 | .704 | .480 | .448 | 2.976 |
| Palp | .466 | .244 | .178 | — | .420 | 1.308 |

*Spines.* First leg: femur dorsal 0–1–1–1–0 on left, 0–1–1–0–0 on right, prolateral 0–0–1–1–1–0, retrolateral 0–0–1–1–0; patella dorsal 1–1, prolateral and retrolateral 1–1; tibia dorsal 0–1–1–0 left, 0–1–1–1–0 on right, prolateral 1–0–1–0, retrolateral 1–1–1–0, ventral 0–2–2–0; metatarsus dorsal 0, prolateral 0–1–0, retrolateral 0, ventral 0–2–2–2 (offset laterally). Second leg: essentially as in first with few exceptions. Third leg: femur dorsal 0–1–1–1–1–0 on right, 0–1–0–1–0 on left, prolateral 0–0–0–1–0; patella dorsal 1–1; tibia dorsal 0–1–0–1–0, prolateral 0–0–1–0, retrolateral and ventral 0; metatarsus dorsal 0, prolateral 1–0–1–0, retrolateral 0–0–1–0, ventral 0–1r–0. Fourth leg: femur dorsal 0–1–1–0 on right, 0–1–1–1–0 on left, elsewhere 0; patella only dorsal 1(bristle)0–1; tibia dorsal 0–0–1–0, prolateral 0–1–1–0, retrolateral 0–0–1–0, ventral 0; metatarsus only prolateral 0–0–1–0. Palpal spines: only two long slender dorsal spines on patella 1–1.

*Palp.* Relatively simple, short and fairly robust. Femur somewhat thickened; greatest width of tibia nearly equal to greatest length. Tibia with a short broad membranous retrolateral apophysis ventral to a short, strongly chitinized tubercle; between these structures there is a low membranous ridge. The tarsus is short and broad with the only visible spine arising as a robust structure near middle of prolateral side and twisting spirally at middle of anterior surface of bulb where it turns backward in a marked enlargement and terminates in a sharp point directed somewhat retrolaterally (Figs. 16–17).

*Abdomen.* Moderately robust; rounded at base; widest just anterior to reduced median dorsal tubercle which lies about one third of total length from posterior end; longer than wide in ratio of about 7 : 4; tapered quite sharply from widest region to anal tubercle which is a fairly prominent and somewhat flattened cone; quite spinose dorsally with each spine usually arising from a yellowish patch; six spinnerets as usual in the genus; a distinct colulus not observed; position of tracheal spiracle near base of spinnerets obscure and not marked by any definite lip or tubercle; with four dorsal sigilla, the posterior pair of which is much larger than anterior pair.

*Color in alcohol.* Carapace generally a rich medium brown with eight lighter radiating and more or less wavy stripes and bands meeting just anterior to the top of smooth posterior declivity; the lighter stripes and bands enclose nine thin yellowish white lines; low along the lateral sides are additional lighter bands and yellowish white lines; clypeus with four lighter perpendicular streaks. Legs generally yellowish; all more or less dotted with reddish spots but third and fourth more so while first and second have more whitish spots but they are also mottled with reddish and brownish along prolateral surfaces

of the femora. Maxillae and palpi yellowish. Lip yellowish in distal third, brownish elsewhere. Chelicerae generally brownish with lighter streaks on anterior surfaces. Sternum lighter brownish. Abdomen: dorsum variegated with different shades of red and yellowish white difficult to describe adequately; lateral sides shiny yellowish white with darker dots arranged in broken longitudinal rows; venter yellowish, dusted with brownish; a rectangular dark patch occupies the region in front of genital groove; a dark narrow ring surrounds bases of spinnerets.

*Type locality.* Male allotype from C. Z. Biological Area, C. Z., August, 1939. Numerous male paratypes and females from the following localities: C. Z. Biological Area, June–July, 1934; June–August, 1936; June–August, 1939; Ft. Randolph and Ft. Davis, C. Z., August, 1936; Madden Dam region, July, 1936 and August, 1939; C. Z. Forest Reserve, C. Z., July–August, 1939; Gamboa, C. Z., August, 1939.

### Tmarus pauper O. P.-Cambridge, 1892

*T. pauper* F. P.-Cambridge, 1900
*T. pauper* Petrunkevitch, 1911
*T. pauper* Petrunkevitch, 1925

The Cambridges had only males from Bugaba. The species has not appeared in my collections and, so far as I know, has not been collected since its original discovery.

### Tmarus parki spec. nov.

Figures 19–20

*Male holotype.* Total length 5.056 mm. Carapace 1.856 mm. long; 1.664 mm. wide opposite second coxae where it is widest; about .960 mm. tall and, therefore, about .57 as tall as wide; very gently arched behind PME to beginning of steep posterior declivity which descends quite steeply to posterior border which is nearly straight; without a definite thoracic groove; ventral margin with irregularities opposite intervals between first and second, and second and third coxae.

*Eyes.* Eight in two rows, all diurnal. LE on moderately prominent tubercles; PME slightly raised from general surface; AME hardly raised at all; viewed from above, posterior row strongly recurved; viewed from in front, anterior row straight measured by centers; central ocular quadrangle wider behind than in front in ratio of 19 : 14, wider behind than long in ratio of 19 : 17; posterior row occupies about

three fourths of width of carapace at that level. Ratio of eyes AME : ALE : PME : PLE=2.5 : 5 : 3 : 4.25. AME separated from one another by nearly four times the diameter of one of them, from ALE by slightly more than three times the diameter of one of them. PME separated from one another by nearly five times the diameter of one of them, from PLE by slightly more than five times the diameter of one of them. Laterals separated from one another by thirteen fifths of the diameter of ALE. Clypeus markedly porrect, thus adding to the length of the carapace. Height of clypeus, including membranous ventral border, equal to nine times the diameter of AME. Clypeus with the usual seven long slender spines near ventral margin, but middle one situated near middle of space beneath AME.

*Chelicerae.* Basal segment .576 mm. long; considerably porrect. Other features as usual in the genus.

*Maxillae.* Only slightly convergent, but basal half encroaches upon lip so that latter has the appearance of being pinched between the two maxillae; basal half robust, distal half moderately slender; longer than lip in ratio of about 3 : 2; longer than wide at middle constriction in ratio of 27 : 8; distal end with a moderately well developed scopula; serrula extends far over lateral surface.

*Lip.* Very narrow at base; longer than wide at base in ratio of 17 : 15; widest in middle; distal end quite squarely truncated and with a row of stiff bristles. Sternal suture gently recurved.

*Sternum.* In general, broadly scutiform; longer than wide in ratio of 6 : 5; widest between second coxae, but nearly as wide between first; posterior end bluntly pointed and not extended between fourth coxae which are separated only by a little less than one fifth of the width of one of them.

*Legs.* 1243. Width of first patella at "knee" .333 mm., tibial index of first leg 11. Width of fourth patella at "knee" .222 mm., tibial index of fourth leg 14.

| | Femora | Patellae | Tibiae | Metatarsi | Tarsi | Totals |
|---|---|---|---|---|---|---|
| | (All measurements in millimeters) | | | | | |
| 1. | 2.496 | .928 | 2.028 | 1.600 | 1.024 | 8.096 |
| 2. | 2.432 | .896 | 2.048 | 1.600 | 1.024 | 8.000 |
| 3. | 1.152 | .480 | 1.056 | .512 | .576 | 3.776 |
| 4. | 1.408 | .512 | 1.024 | .512 | .576 | 4.032 |
| Palp | .544 | .288 | .224 | — | .576 | 1.632 |

*Spines.* First leg: femur dorsal 0–0–1–1–1–0, prolateral 0–1–1–1–1–0, retrolateral 0–1–1–1–0; patella dorsal 1–1, prolateral and retrolateral 0–1–0; tibia dorsal 0–1–0–1–0, prolateral and retrolateral

–0–11–1–0, ventral 1r–2–2–0; metatarsus dorsal 0, prolateral and retrolateral 1–1–0, ventral 2–2–2–2. Second leg: femur as in first except retrolateral 0–0–1–1–0; patella and metatarsus as in first; tibia as in first except ventral 0–2–2–0. Third leg: femur dorsal 0–1–1–0, prolateral 1–0–1–0; patella dorsal 1–1, prolateral and retrolateral spines replaced by bristles; tibia dorsal 0–1–1–0, prolateral and retrolateral 0–0–1–0, ventral 0–1p–0; metatarsus dorsal 0, prolateral 0–1–0, retrolateral 1–1–0, ventral 0–2–0. Fourth leg: femur and patella as in third except patella retrolateral 0–1(weak)–0; tibia as in third except prolateral 0–1–1–0; metatarsus dorsal 0, prolateral and retrolateral 0–1–0, ventral 0–2–1p. Palpal spines: femur dorsal 0–1–2(weak); numerous other long slender spines irregularly placed on patella, tibia, and tarsus.

*Palp.* Complicated; only tibia and tarsus modified. Tibia with a dorsal and ventral retrolateral apophysis; ventral apophysis arises toward the base of the tibia as a strongly chitinized spur curving gently toward the long dorsal apophysis which arises from the extended distal margin of the tibia as a stout long pointed spur reaching considerably beyond middle of bulb. Bulb with three characteristic features as follows: a strongly chitinized ridge arises near retrolateral side, turns toward prolateral side, extends somewhat diagonally across near posterior margin, then turns at a right angle and terminates as a sharply pointed spine; a centrally placed chitinized ridge extends to anterior margin; the embolus arises on prolateral side, curves to anterior border where a prominent swelling occurs and then extends to retrolateral side where it terminates in a slender spine (Figs. 19–20).

*Abdomen.* Elongated and generally cylindrical in shape with sides nearly parallel from bluntly rounded base to near posterior end; longer than wide in ratio of 27 : 7; dorsally and dorsolaterally with many long slender spines each arising from a distinct pit; other features as usual in the genus.

*Color in alcohol.* Carapace generally yellowish; somewhat darkened areas with lighter streaks indicate that in nature there may be a more definite color pattern than shows in the holotype; the usual whitish areas around all eyes but particularly around LE. Mouth parts, legs, and sternum all yellowish with legs darker above. Abdomen: generally yellowish; with a whitish patch at base; dorsum with many irregular small whitish patches; each spine arises from a small yellowish area with each area more or less surrounded by an irregular whitish ring; laterally and ventrolaterally with numerous small yellowish dots in a whitish background; venter yellowish with a vague darker patch just anterior to genital groove and another just anterior to tracheal spiracle.

*Type locality.* Male holotype from C. Z. Biological Area, C. Z., July, 1936. No paratypes.

Note: *T. parki* sp. nov. is regarded as being very closely related to *T. peregrinus* sp. nov. The species is dedicated to Dr. Orlando Park, Northwestern University, Evanston, Illinois with whom I collected in the C. Z. Biological Area throughout the greater part of the summer of 1936.

### TMARUS PEREGRINUS spec. nov.

Figures 21–22

*Male holotype.* Total length 4.80 mm. Carapace 1.920 mm. long; 1.632 mm. wide opposite second coxae where it is widest; .825 mm. tall and, therefore, about .50 as tall as wide; almost level behind PME to steep posterior declivity; otherwise essentially as in *T. parki.*

*Eyes.* Viewed from in front, anterior row gently procurved, measured by centers; central ocular quadrangle wider behind than in front in ratio of about 7 : 5; wider behind than long in ratio of about 21 : 17; posterior row occupies about eleven fifteenths of width of carapace at that level. Ratio of eyes AME : ALE : PME : PLE = 3 : 5.5 : 4 : 5. AME separated from one another by ten thirds of the diameter of one of them, from ALE by three times the diameter of one of them. PME separated from one another by seven halves of the diameter of one of them, from PLE by slightly more than four times the diameter of one of them. Laterals separated from one another by nearly three times the diameter of PLE. Clypeus considerably porrect, thus adding considerably to the length of the cephalothorax. Width of clypeus, including membranous ventral border, nearly seven times the diameter of AME. Otherwise essentially as in *T. parki.*

*Chelicerae.* Only slightly porrect; basal segment .704 mm. long; other features as usual in the genus.

*Maxillae.* Longer than lip in ratio of 15 : 11; longer than wide at middle constriction in ratio of 15 : 4; otherwise essentially as in *T. parki.*

*Lip.* Longer than wide at base in ratio of about 3 : 1; sternal suture straight; otherwise essentially as in *T. parki.*

*Sternum.* Somewhat more elongated than in T. parki sp. nov.; moderately convex; longer than wide in ratio of about 23 : 16; fourth coxae separated by about one third of their width. Otherwise as in *T. parki.*

*Legs.* 1 = 243. Width of first patella at "knee" .3108 mm., tibial index of first leg 10. Width of fourth patella at "knee" .222 mm., tibial index of fourth leg 13.

| | Femora | Patellae | Tibiae | Metatarsi | Tarsi | Totals |
|---|---|---|---|---|---|---|
| | (All measurements in millimeters) | | | | | |
| 1. | 2.560 | .896 | 2.176 | 1.664 | 1.024 | 8.320 |
| 2. | 2.688 | .896 | 2.048 | 1.664 | 1.024 | 8.320 |
| 3. | 1.376 | .576 | 1.152 | .640 | .576 | 4.320 |
| 4. | 1.600 | .544 | 1.120 | .640 | .576 | 4.480 |
| Palp | .576 | .320 | .256 | — | .608 | 1.760 |

*Spines.* First leg: femur dorsal 0–0–1–1–0, prolateral and retrolateral 0–1–1–1–0, ventral 0 (spines recorded here are as they occur on right side; on left side there are ten with irregular placement); patella dorsal 1–1, prolateral and retrolateral 0–1–0; tibia dorsal 0–1–0–1–0, prolateral and retrolateral 0–1–1–1–0, ventral 0–1p–2–1p–2–0 on right, 0–2–2–0 on left; metatarsus dorsal 0–1–0–0, prolateral and retrolateral 2–2–0, ventral 1p–2–2–2 on left, but 2–2–1p–2–2 on right with some irregularity of placement. Second leg: femur and patella as in first except femur prolateral 0–1–1–1–0–1–0 on right with left leg missing; tibia as in first except ventral 0–2–2–0; metatarsus dorsal 0, prolateral and retrolateral 1–1–0, ventral 0–2–2–2. Third leg: femur only dorsal 0–1–1–1–0 and prolateral 1–0–1–0; patella doral 1–1 and probably prolateral and retrolateral 0–1–0; tibia dorsal 0–1–1–0, prolateral and retrolateral 0–0–1–0, ventral 0–2–0; metatarsus dorsal 0; prolateral and retrolateral 0–1–0, ventral 0–2–0, Fourth leg: femur only dorsal 0–1–1–0 and prolateral 0–1–1–1–0; patella only dorsal 1–1 and prolateral 0–1(weak)–0; tibia dorsal 0–1–1–0, prolateral 0–1–1–0, retrolateral 0–0–1–0, ventral 0–1p–0; metatarsus dorsal 0, prolateral and retrolateral 0–1–0, ventral 0–2–1p. Palpal spines: femur dorsal 0–1–2, prolateral 0–0–1; several long slender spines irregularly placed on patella and tibia.

*Palp.* Complicated; only tibia and tarsus modified. Tibia with two retrolateral apophyses; the ventral one a strongly chitinized hook-like process; the dorsal one also strongly chitinized and somewhat flask-shaped spur. Bulb of tarsus with a basal hook; at anterior margin of bulb a broad band terminates on retrolateral side in two hooks, the larger of which is regarded as the embolus. Similar to but clearly distinct from that of *T. parki.* (Figs. 21–22).

*Abdomen.* Longer than wide in ratio of 25 : 8. Otherwise essentially as in *T. parki.*

*Color in alcohol.* Almost identical with that of *T. parki* except that the abdominal markings are somewhat less distinct than in that species.

*Type locality.* Male holotype from C. Z. Biological Area, C. Z., July, 1934. No paratypes. Probably an unusual species.

Note: This species and *T. parki* were at first sorted out and placed together on account of their close resemblance to one another. A careful study has clearly revealed that they must be regarded as representing two clearly distinct, but closely related, species.

### TMARUS PROBUS spec. nov.

Figures 23–24

*Male holotype.* Total length 3.584 mm. Carapace 1.344 mm. long; 1.216 mm. wide opposite second coxae where it is widest; .672 mm. tall and, therefore, about .55 as tall as wide; nearly level from just behind PME to beginning of steep posterior declivity opposite interval between third and fourth coxae; without a definite median thoracic groove; ventral margin regularly and quite fully rounded from constriction beneath interval between LE to posterior border which is very concave.

*Eyes.* Eight in two rows, all diurnal. LE on prominent tubercles; PME somewhat raised from general surface; AME hardly raised at all; viewed from above, posterior row strongly recurved; viewed from in front, anterior row gently procurved measured by centers; central ocular quadrangle wider behind than in front in ratio of 15.5 : 11.5; posterior row occupies slightly more than full width of carapace at that level. Ratio of eyes AME : ALE : PME : PLE=2.5 : 5 : 3 : 4.5. AME separated from one another by slightly less than three times the diameter of one of them, from ALE by three diameters of one of them. PME separated from one another by ten thirds of the diameter of one of them, from PLE by slightly less than five times the diameter of one of them. Laterals separated from one another by twelve fifths of the diameter of ALE. Clypeus quite porrect thus adding somewhat to length of cephalothorax. Width of clypeus, including membranous ventral margin, equal to nearly six and a half times the diameter of AME. Clypeus with the usual seven spines near ventral margin, including the one set a little above the others beneath interval between AME.

*Chelicerae.* Only slightly porrect; basal segment .576 mm. long; with one long slender spine on each in front, about one third from base and near medial surface together with several shorter, weaker spines hardly more than bristles along medial surface; otherwise as usual in the genus from Panama.

*Maxillae.* Longer than lip in ratio of 11 : 7; longer than wide at middle constriction in ratio of about 22 : 7; basal half with a row of three very slender spines through middle; distal half with numerous

bristles and a few long slender spines; otherwise essentially as in *T. parki*.

*Lip.* Longer than wide at base in ratio of 15 : 7; wider at base than at distal end in ratio of 7 : 4; distal end squarely truncated with a row of stiff black bristles. Sternal suture straight or slightly recurved.

*Sternum.* Broadly scutiform; longer than wide in ratio of 18 : 15; moderately convex; posterior end a blunt point, not extended between fourth coxae which are separated by three fifths the width of one of them.

*Legs.* 1243. Width of first patella at "knee" .222 mm., tibial index of first leg 10. Width of fourth patella at "knee" .1770 mm., tibial index of fourth leg 14.

| | Femora | Patellae | Tibiae | Metatarsi | Tarsi | Totals |
|---|---|---|---|---|---|---|
| | | | (All measurements in millimeters) | | | |
| 1. | 1.856 | .672 | 1.664 | 1.344 | .832 | 6.368 |
| 2. | 1.856 | .640 | 1.632 | 1.280 | .832 | 6.240 |
| 3. | .960 | .384 | .800 | .511 | .480 | 3.135 |
| 4. | 1.088 | .384 | .832 | .512 | .480 | 3.296 |
| Palp | .444 | .222 | .155 | — | .511 | 1.332 |

*Spines.* First leg: femur dorsal 0–1–1–1–0, prolateral 1–1–1–1–0, retrolateral 0–0–1–1–0; patella dorsal 1–1, prolateral and retrolateral 0–1–0; tibia dorsal 0–1–0–1–0, prolateral and retrolateral 1–1–1–0, ventral 0–2–2–0; metatarsus dorsal 0, prolateral 1–1–1–0, retrolateral 0–1–1–0, ventral 0–2–2–2. Second leg: essentially as in first. Third leg: femur only dorsal and prolateral 0–1–1–0 on right, prolateral on left 0–0–1–0; patella only dorsal 1–1; tibia dorsal 0–1–0–1–0, prolateral and retrolateral 0–1–0, ventral 0–2–0; metatarsus dorsal 0, prolateral and retrolateral 0–1–0, ventral 0–2–0. Fourth leg: left almost completely devoid of spines; right as follows: femur and patella as in third except femur prolateral 0-0-1-0; tibia as in third except ventral 0–1p–0; metatarsus as in third. Palpal spines: femur dorsal 0–1–1–2(some irregularity in placement); patella, tibia, and tarsus with several long slender spines irregularly placed.

*Palp.* Complicated; only tibia and tarsus modified. Tibia with two retrolateral apophyses; ventral one a stout hook; dorsal one a long, sharply pointed spur curved ventrally and provided with four small denticles, only seen in ventral view. Bulb with a short stout basal spine, a longer retrolateral and more slender spine, probably the embolus, a central semilunate ridge, and a distal and somewhat retrolateral, triangular, striated structure, and between the base of the basal spine and the striated structure a broad low shell-like structure extends (Figs. 23–24).

*Abdomen.* Elongated and more or less cylindrical; longer than wide in ratio of about 38 : 13; widest about three fifths from base; a slightly raised median dorsal region capped by a cluster of five spines may indicate the position of a reduced tubercle and a caudal "appendage" a short distance anterior to anal tubercle. Otherwise as usual in the genus from Panama.

*Color in alcohol.* Carapace generally a clear yellowish; dorsal area with irregular reddish spots arranged in a pair of short vague stripes; clypeus reddish along ventral margin and beneath ALE; with a narrow reddish ventral border; with a few small isolated reddish spots along lateral sides. Legs generally yellowish; femora one and two with many small reddish prolateral spots. Mouth parts and sternum yellowish. Abdomen: generally yellowish; small reddish dots are clustered at base of dorsum; a small red dot lies at base of many of the numerous long slender spines; a very narrow median white stripe from base to the first of a series of narrow white bars; the first bar is about two thirds of total length from base; the third bar is short and the fourth and last bar is confined to the suppressed median dorsal tubercle and broken into separate small spots; laterally with vague dark brownish and occasionally reddish spots; venter yellowish with small irregular dark spots in region of tracheal spiracle.

*Type locality.* Male holotype from Madden Dam region, C.Z., August, 1939. Seven male paratypes from the following localities: Balboa, C. Z., August, 1936; El Valle, R. P., July, 1936; Arraijan, R. P., August, 1936; Taboga Island, R. P., August, 1946 (N. L. H. Kraus); Cocoli, C. Z., August, 1946 (N. L. H. Kraus); the last two loaned for study by Dr. W. J. Gertsch.

Note: This species is regarded as being closely related to *T. studiosus* O. P.-Cambridge.

### TMARUS PRODUCTUS spec. nov.

Figures 25–26

*Male holotype.* Total length 3.328 mm. Carapace 1.280 mm. long; 1.216 mm. wide between second coxae where it is widest; .640 mm. tall and, therefore, about .53 as tall as wide; nearly level behind PME to beginning of steep posterior declivity which is quite steeply arched to posterior border; without any definite thoracic groove; well rounded from opposite interval between LE to posterior border which is only gently concave; ventral border regularly rounded.

*Eyes.* Eight eyes in two rows, all diurnal. LE on moderately prominent tubercles; ME on slightly raised tubercles; viewed from above,

posterior row strongly recurved; viewed from in front, anterior row straight measured by centers; central ocular quadrangle wider behind than in front in ratio of 7 : 4, wider behind than long in ratio of 14 : 13; posterior row occupies nearly full width of carapace at their level. Ratio of eyes AME : ALE : PME : PLE = 2.3 : 5.5 : 3 : 5. AME separated from one another by a little less than two diameters of one of them, from ALE by nearly two diameters of one of them. PME separated from one another by seven thirds of the diameter of one of them, from PLE by a little less than four diameters of one of them. LE separated from one another by slightly more than two diameters of PLE. Clypeus moderately porrect. Width of clypeus, including membranous ventral border, equal to a little more than five diameters of AME.

*Chelicerae.* Only slightly porrect; basal segment .448 mm. long. Other features as usual in the genus from Panama.

*Maxillae.* Slightly convergent; basal half considerably inflated, distal half moderately slender; longer than wide at middle constriction in ratio of 13 : 7; distal end with a moderately well developed scopula; serrula extends far over outer distal corner and lateral surface.

*Lip.* Longer than wide at base in ratio of 13 : 6; not much wider at middle than at base; distal end well rounded, with a cluster of black bristles. Sternal suture straight.

*Sternum.* Broadly scutiform; longer than wide in ratio of 17 : 16; quite convex; widest between second coxae but nearly as wide between first coxae; well supplied with a covering of short slender bristles; posterior end bluntly pointed, not extended between fourth coxae which are separated by about their width.

*Legs.* 1243. Width of first patella at "knee". .2442 mm., tibial index of first leg 9. Width of fourth patella at "knee" .2220 mm., tibial index of fourth leg 16

| | Femora | Patellae | Tibiae | Metatarsi | Tarsi | Totals |
|---|---|---|---|---|---|---|
| | | | (All measurements in millimeters) | | | |
| 1. | 2.240 | .704 | 2.048 | 1.568 | .896 | 7.456 |
| 2. | 2.176 | .704 | 1.984 | 1.536 | .896 | 7.296 |
| 3. | 1.088 | .384 | .832 | .512 | .480 | 3.296 |
| 4. | 1.152 | .416 | .960 | .576 | .544 | 3.648 |
| Palp | .512 | .232 | .192 | — | .576 | 1.512 |

*Spines.* First leg: femur dorsal 0–0–1–1–0, prolateral 0–1–1–1–0, retrolateral 0–0–1–1–0; patella only dorsal 1–1; tibia dorsal 0–1–0–0–0, prolateral and retrolateral 1–1–1–0, ventral 0–2–1p–0; metatarsus dorsal 0, prolateral 0–1–0, retrolateral 1–1–0, ventral 0–2–2–1–0.

Second leg: femur as in first except prolateral 0–0–1–1–0; patella as in first; tibia dorsal as in first, prolateral and retrolateral 0–1–1–0, ventral 0–2–2–0; metatarsus dorsal 0, prolateral and retrolateral 0–1–0, ventral 0–2–2–0. Third leg: femur only dorsal 0–1–1–0; patella only dorsal 1–1; tibia only dorsal 0–0–1–0 and ventral 0–1p–0; metatarsus only prolateral 0–1–0 and ventral 0–2–0. Fourth leg essentially as in third.

*Palp.* Complicated; only tibia and tarsus modified. Tibia with two long, strongly chitinized, retrolateral apophyses lying close together and extending beyond middle of bulb on retrolateral side; near base of ventral apophysis there occurs a short stout chitinized hook. Cymbium with a characteristic notch near tip on retrolateral side. The most characteristic feature of the bulb is an embolus which arises near distal margin, describes almost a complete circle as a deeply grooved and spirally twisted band, after which it proceeds to describe a long loose loop opposite the base of the tarsus and the body of the tibia where it turns back distally after more twisting to terminate as a fine thread near tip. Through much of the distance from origin to termination the embolus is far removed ventrally from the surface of the bulb (Figs. 25–26).

*Abdomen.* Total length 1.984 mm.; longer than wide in ratio of 31 : 17 at widest part, about two fifths of total length from posterior end; blunt at base, tapered to a point from widest part to tip of anal tubercle; apparently with two nearly suppressed dorsal tubercles about one third from base, with each supplied with a long stout spine; also with a single reduced median dorsal tubercle opposite widest part; other features as usual in the genus from Panama.

*Color in alcohol.* Among the more highly colored species of the genus. Carapace: with a yellowish white triangular area with apex at top of steep posterior declivity and base including eye region; within this area are brownish dots and whitish lines; steep posterior declivity darker yellowish; elsewhere brown with whitish lines and streaks; clypeus with a whitish band across the center and brownish with many lighter streaks elsewhere. Legs: generally yellowish with many small irregular reddish brown and whitish spots; on femora especially, but also to a lesser extent on some other segments these spots are lacking; first and second femora with a ventral black spot at distal end; first and second tibiae with a dorsal white spot at distal end; first and second metatarsi each with a narrow black distal band. Chelicerae dark brownish in front with a whitish streak along dorsolateral edge connecting with a distal medial white spot. Palpal cymbium nearly black dorsally. Elsewhere mouth parts and sternum yellowish. Abdomen: with a somewhat vaguely outlined sagittate lighter colored

stripe from base to reduced median dorsal tubercle; behind tubercle there is another delimited whitish stripe crossed by several narrow reddish lines; elsewhere dorsum and lateral sides darkly variegated with black, white, and reddish dots and streaks intercommunicating; venter yellowish with a dark patch just in front of genital groove, ventrolaterally whitish.

*Type locality.* Male holotype from Porto Bello, R. P., August, 1936. No paratypes.

### Tmarus sigillatus spec. nov.

Figures 27–28

*Male holotype.* Total length 4.256 mm. Carapace 1.792 mm. long; 1.600 mm. wide opposite second coxae where it is widest; .704 mm. tall and, therefore, about .44 as tall as wide; gently arched behind PME to steep posterior declivity; declivity steeply arched to posterior border which is moderately concave in middle; ventral border somewhat irregular in outline along lateral sides.

*Eyes.* Eight in two rows, all diurnal; LE on prominent tubercles; PME on small tubercles; AME slightly raised from general surface; viewed from above, posterior row strongly recurved; viewed from in front, anterior row somewhat more recurved than usual in the species, measured by centers; central ocular quadrangle wider behind than in front in ratio of 19 : 14, wider behind than long in ratio of 19 : 16; posterior row occupies the full width of carapace at their level. Ratio of eyes AME : ALE : PME : PLE = 3 : 6 : 4 : 5.3 AME separated from one another by three diameters of one of them, from ALE by nearly three diameters. PME separated from one another by nearly three and a half diameters of one of them, from PLE by four diameters of one of them. Laterals separated from one another by nearly two diameters of ALE. Clypeus quite porrect. Height of clypeus, including narrow membranous ventral border, equal to nearly five and one half diameters of AME. Clypeus with the usual seven spines along the ventral border of chitinous area.

*Chelicerae.* Only slightly porrect; basal segment .644 mm. long. Other features as usual in the genus from Panama.

*Maxillae.* Slightly convergent; basal half considerably inflated, distal half much slenderer; longer than wide at middle constriction in ratio of 15 : 4; longer than lip in ratio of 3 : 2; other features as described for *T. productus*.

*Lip.* Longer than wide at base in ratio of 5 : 2; sternal suture straight; other features as described for *T. productus*.

*Sternum.* Longer than wide in ratio of 43 : 35; fourth coxae separated by three sevenths of their width. Otherwise essentially as described for *T. productus.*

*Legs.* 1234. Width of first patella at "knee" .3552 mm., tibial index of first leg 11. Width of fourth patella at "knee" .2664 mm., tibial index of fourth leg 17.

| | Femora | Patellae | Tibiae | Metatarsi | Tarsi | Totals |
|---|---|---|---|---|---|---|
| | | | (All measurements in millimeters) | | | |
| 1. | 3.200 | .992 | 2.880 | 2.496 | 1.120 | 10.688 |
| 2. | 3.136 | .992 | 2.816 | 2.304 | 1.024 | 10.272 |
| 3. | 1.280 | .576 | 1.216 | .704 | .576 | 4.352 |
| 4. | 1.408 | .544 | 1.024 | .704 | .576 | 4.256 |
| Palp | .576 | .288 | .256 | — | .576 | 1.696 |

*Spines.* First leg: femur dorsal 1–1–1–1—1–0, prolateral 0–0—1–1–1 (crowded and irregular)–1–0, retrolateral 0–0–1–1–0, ventral 0; patella dorsal 1–1, prolateral and retrolateral 0–1–0; tibia dorsal 0–1–0–1–0, prolateral and retrolateral 0–1–1–1–0, ventral 0–2–2(both pairs irregular in position)–1p–0; metatarsus dorsal 0, prolateral and retrolateral 0–1–1–0–0, ventral 0–1r–2(irregular)–1r–1p–2–2. Second leg: femur dorsal 0–1(bristle)–1–1–0, prolateral 0–1–1–1–0, retrolateral 0–0–1–1–0; patella as in first; tibia as in first except ventral 0–2–2–0; metatarsus dorsal 0, prolateral and retrolateral 0–1–1–0–0, ventral 0–2–2–2–2–2. Third leg: femur only dorsal 0–1–1–0 and prolateral 0–0–1–0; patella only dorsal 1–1; tibia dorsal, prolateral, and retrolateral 0–0–1–0, ventral 0–1p–0; metatarsus dorsal 0, prolateral 0–1–1–0–0, retrolateral 0–0–1–0, ventral 0–2–0–0. Fourth leg: femur only dorsal 0–1–0–1–0; patella as in third; tibia dorsal 1–0–1–0, prolateral and retrolateral as in third, ventral 0; metatarsus only prolateral 0–1–1–0, retrolateral 0–1–0, ventral 0–2–0–0. Claws: on second leg, pectinate in a single row with eight or nine teeth.

*Palp.* Complicated; only tibia and tarsus modified. Tibia with two distal retrolateral apophyses; the ventral of these is a strongly chitinized spur; the dorsal is a blunt, rounded, strongly chitinized process, concave toward the spur. The bulb is deeply excavated toward the retrolateral side; there is a short, sharply pointed spine contiguous to the tibial spur; opposite this spine on the prolateral side of the bulb there is a strongly chitinized hook. The embolus extends from the retrolateral side of the base of the bulb around nearly three fourths of the margin of the bulb and terminates in a marked dilation bluntly truncated at its tip (Figs. 27–28). The tibia appears to support a cluster of four dorsal trichobothria.

*Abdomen.* Elongated and more or less cylindrical; longer than wide in ratio of 21 : 10; widest about five eighths from base; a short distance behind widest part is a low median dorsal tubercle; dorsal and dorsolateral areas with numerous stout and apparently erectile spines each arising from a somewhat conspicuous red-tipped tubercle. Other features as usual in the genus from Panama.

*Color in alcohol.* Carapace a light brownish, speckled with yellowish flecks and, along the margins of the posterior declivity, irregular brown spots; a V-shaped area extending from PLE to beginning of steep posterior declivity is margined by an irregular yellowish border; sternum is yellowish. Legs generally yellowish with many small reddish spots especially along prolateral surfaces of femora of first two pairs. Abdomen: dorsal area highly variegated with irregular yellowish, reddish, and black streaks and spots; just lateral to the median dorsal tubercle on each side is an irregular black spot; venter is a yellowish with a double row of small lighter colored dots extending from in front of tracheal spiracle to genital groove and diverging somewhat anteriorly.

*Type locality.* Male holotype from Canal Zone Forest Reserve, C. Z., August, 1939. No Paratypes.

### Tmarus studiosus O. P.-Cambridge, 1892

Figures 29–31

*T. studiosus* F. P.-Cambridge, 1900
*T. studiosus* Petrunkevitch, 1911
*T. studiosus* Petrunkevitch, 1925
*T. studiosus* Banks, 1929

The Cambridges had both sexes from Bugaba, Panama. Mr. Banks had both sexes from the C. Z. Biological Area, C. Z. I have numerous specimens of both sexes from the following localities: C. Z. Biological Area, June–July, 1934; June–August, 1936; June–August, 1939; June–October, 1940 (Zetek, Berlese funnel); Gamboa and Ft. Sherman, C. Z., August, 1939.

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# PLATES

PLATE 1

## PLATE 1

External Anatomy of Spiders

Fig. 1. *Tmarus aculeatus* Chickering; male palp, ventral view.
Fig. 2. *T. bucculentus* Chickering; epigynum, ventral view.
Fig. 3. *T. cognatus* Chickering: epigynum, ventral view.
Fig. 4. *T. contortus* Chickering; male palp, ventral view.
Fig. 5. *T. contortus* Chickering; epigynum, ventral view.
Fig. 6. *T. corruptus*; epigynum, ventral view (redrawn from F. Cambridge).
Fig. 7. *T. curvus* Chickering; male palp, ventral view.
Fig. 8. *T. curvus* Chickering; epigynum, ventral view.

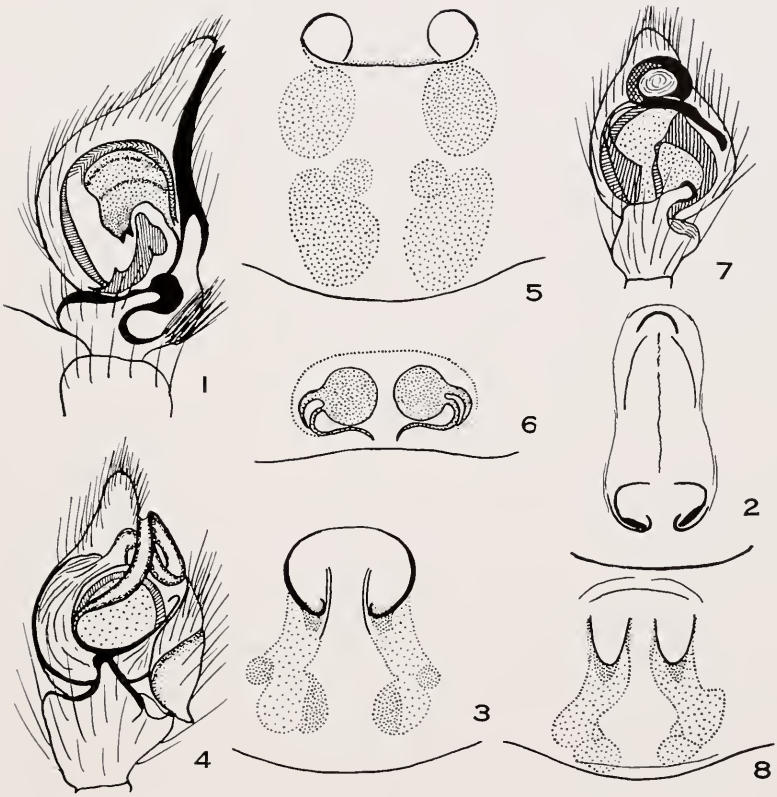
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PLATE 2

## PLATE 2

External Anatomy of Spiders

Fig. 9. *Tmarus decens;* epigynum, ventral view (redrawn from F. Cambridge).
Fig. 10. *T. ineptus;* male palp, ventral view.
Fig. 11. *T. ineptus;* epigynum, ventral view.
Fig. 12. *T. intentus;* epigynum, ventral view.
Fig. 13–14. *T. morosus* Chickering, male palp, ventral and retrolateral views, respectively.
Fig. 15. *T. morosus* Chickering; epigynum, ventral view.

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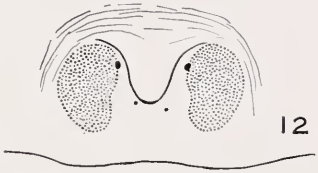
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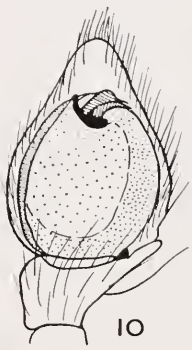
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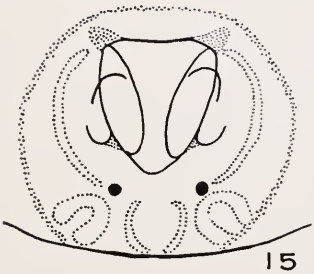
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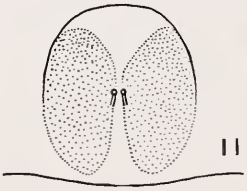
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PLATE 3

## PLATE 3

External Anatomy of Spiders

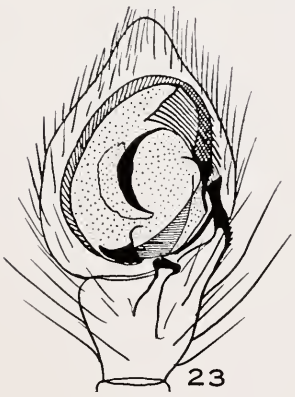
Figs. 16–17. *Tmarus mundulus;* male palp, ventral view and palpal tibia, retrolateral view, respectively.

Fig. 18. *T. mundulus;* epigynum, ventral view.

Figs. 19–20. *T. parki* Chickering; male palp, ventral view and palpal tibia, retrolateral view, respectively.

Figs. 21–22. *T. peregrinus* Chickering; male palp, ventral view and palpal tibia, retrolateral view, respectively.

Fig. 23. *T. probus* Chickering; male palp, ventral view.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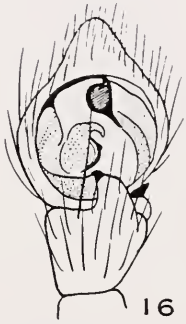
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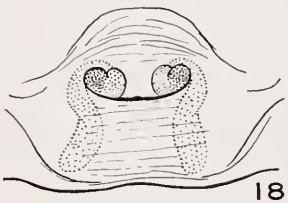
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PLATE 4

## PLATE 4

External Anatomy of Spiders

Fig. 24. *Tmarus probus* Chickering; palpal tibia, retrolateral view.

Figs. 25–26. *T. productus* Chickering; male palp, ventral view and palpal tibia, retrolateral view, respectively.

Figs. 27–28. *T. sigillatus* Chickering; male palpal tibia, retrolateral view and male palp, ventral view, respectively.

Figs. 29–30. *T. studiosus;* male palp, ventral view and palpal tibia, retrolateral view, respectively.

Fig. 31. *T. studiosus;* epigynum, ventral view.

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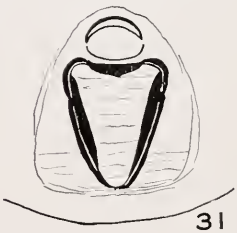
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AT HARVARD COLLEGE
Vol. 103, No. 5

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# BALTIC AMBER SPIDERS IN THE MUSEUM OF COMPARATIVE ZOÖLOGY

By Alexander Petrunkevitch

With Twenty-seven Plates

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No. 5 — *Baltic Amber Spiders in the Museum of Comparative Zoölogy*[1]

By Alexander Petrunkevitch[2]

The collection of Baltic Amber spiders, which forms the subject of the present contribution is interesting in several respects. While partly consisting of young spiderlings of the second or third instar the identification of which is of very doubtful value from the point of view of modern Arachnology, there still remain a number of mature individuals of both sexes, the identification of which is beyond cavil, and some submature specimens sufficiently well preserved to permit detailed description, and thus make the recognition of other specimens of amber spiders of the same species possible and, indeed, safe. Of course, such identification requires very careful study of all, even minutest characters and measurements of all parts. It also requires line drawings without which identification on the basis of a most detailed description could be regarded at best as a first approximation. But the same method of detailed description and figuring has to be accorded even fully mature specimens, if one wishes to consider them in the light of phylogenetic problems. The figuring only of the palp or of the epigynum, sufficient for the identification of the species is quite inadequate for any other purpose.

An interesting feature of the collection is the light which it sheds on the internal anatomy, regeneration, physiology etc. of spiders of the Baltic Amber period. Taken with the information contained in the numerous investigations of Recent spiders it proves that spiders of the Baltic Amber period already possessed to the minutest detail all essential features of anatomy and behavior of their now living relatives and differed from them only in specific, to a considerable extent in generic and to a much lesser one in familial characters. Thus far neither former investigators of the Baltic Amber spider fauna, nor myself found any Recent species among them. Nor are the genera which are represented in both the Baltic Amber and the Recent fauna closely related to the present European fauna. On the contrary, genera which have European species are few and are widely distributed, while those which have no European species are more numerous and have now living species in distant countries, such as South Africa, Malay peninsula, Australia, South America. Moreover, entire families not found in Europe, are represented in the Baltic Amber, namely Archaeidae and Psechridae. And while each of these

[1] Published with the aid of a special gift from Mr. George R. Agassiz.

[2] A Contribution from the Osborn Zoological Laboratory of Yale University.

two families is represented by a single genus, they seem to have been fairly common. In fact, the Family Archaeidae has more species in the Baltic Amber than in those foreign regions in which Archaeidae are still living. Nor can this fact be interpreted as evidence of their "primitive" or "ancestral" nature. On the contrary, they are highly specialised and were most probably handicapped in their struggle for existence by being unable to adapt themselves to new environmental conditions on account of their specialization. In that respect the name Archaea is truly a misnomer. Not one anatomical feature of the Baltic Amber species can be regarded as more primitive than what is found in Recent species.

The high specialization of the Baltic Amber spider fauna is also immediately apparent when one examines a palp of a mature male, such as shown in figures 56, 57, 83, and 109, drawn under fairly high magnification. The details of their structure are quite on a par with the details of corresponding structures in Recent species belonging to the same families. In many cases a figure of the palp would be sufficient for identification of the species. Unfortunately, the palp is often in a flexed condition and the structure of the copulatory apparatus is then only imperfectly visible. For some unknown reason the structure of the epigynum in female specimens is very rarely visible. In most cases the ventral surface of the entire abdomen is coated with a white emulsion impenetrable to light at least inasmuch as any detail and often even the outline of the epigynum is concerned. Nevertheless the few cases in which the epigynum is visible, as shown in figures 68, 69 and 127, make it certain that the epigynum was also as highly developed as in Recent species.

The same may be said about the spinnerets. In Recent spiders spinnerets are used at best as familial characters. This is due primarily to the difficulty of properly studying them on specimens which one does not want to destroy or to mutilate. In amber species, when visible, they furnish important additional characters for the recognition of the species. The number and disposition of the spinning tubes as shown in figures 46 to 48, and 97 and 98, should never be disregarded.

Autotomy of appendages was common in Baltic Amber spiders and the point of severance was the same as in Recent species. This is borne out by the number of individuals with one or more legs missing, the coxo-trochanterial articulation showing the healed surface. A case like the one shown in figure 204 is particularly instructive, inasmuch as the two severed legs may be seen lying in front of the spider and the ends of their coxae are clearly discernable on the left side of the carapace. It shows that the spider tried to free itself from the hold of

the sticky gum in which it was caught, by breaking off two of its legs before it was completely engulfed. On the other hand the exuvium of *Segestria elongata* shown in figure 169 suggests that regeneration was still possible in case the end of a leg was severed before the entire leg could be broken off. In the case of this particular spider the regenerated end is shown in figure 170. It consists of a single segment although there should be two segments, metatarsus and tarsus, the latter ending in claws in an uninjured specimen. The regenerated single-jointed piece lacks claws.

This exuvium, shown in figure 169, shows two other interesting features. Its foregut is complete (figure 172) and in every detail like the foregut of Recent species of the same genus. So is the structure of the edge of its sternum (figure 158 is so much like it, although made from another species, that a separate drawing seemed to be unnecessary). The eyes shown in figure 171 illustrate a case of abnormal development: the lens of the left anterior lateral eye is twice as small as the lens of the corresponding right eye.

An exuvium of *Eocryphoeca gracilipes* is preserved with the molting web in which it was left by the spider. A part of this web is shown in figure 179. But of greater interest than this web are the silk threads of *Ephalmator fossilis*, shown in figures 175 and 99 and 104. They belong to the type with viscid droplets commonly found in Recent orb webs. Bachofen-Echt figured similar silk threads in Baltic Amber in 1934, but his specimen was not accompanied by either an exuvium or an embalmed spider and the identity of the silk remained conjectural. The specimen in the collection of the Museum of Comparative Zoölogy is in every respect superior. The spider died in the process of producing silk threads and each individual thread can be traced under microscope to the corresponding spinning tube. The spider itself is so well preserved that a detailed description of it was possible and will be found below. Whether it was a maker of orb-webs or webs of a pattern different from anything known today remains of course unknown. But the appearance of the threads is similar to that with which we are familiar in the case of Recent spiders. It is interesting that so many of the droplets retained their individuality as globules instead of merging with each other. This phenomenon must be attributed to the physical properties of both the silk and the still fluid amber at the time the spider was entangled in it.

There are very few amber spiders showing color patterns except such as are due to a different degree of darkness of the chitin. The collection of the Museum of Comparative Zoölogy has one specimen, however, in which the color pattern was undoubtedly due to other pigment than the one normally responsible for the more or less rufous

color of chitin. This is *Caduceator quadrimaculatus* shown in figures 202 and 125. Here we have to do with hair which appears to be white, may have been of some other color, red or blue, which faded out with time, but which must have been different from the rufous color of most of the body surface.

Of the internal organs the muscles in the appendages are the most commonly preserved. Such a case is shown in figure 209. The individual muscles shrank and their connection with the articulation points is severed, but otherwise they are well preserved. Their number and disposition seems to be the same as in Recent spiders.

Of exceptional interest is the case of *Paruroctea blauvelti* shown in figure 186. Here not only the muscles of the appendages are at least partially preserved, but the entire abdominal visceral mass is sufficiently well preserved to show clearly the "liver" (chylenteron), the ovary and the heart. The heart is shown in figure 174. But perhaps the most interesting case is that of *Eothanatus diritatis* in which a portion of the abdominal wall is so perfectly preserved that the limits between the cells and the nucleus within each cell are clearly visible under high power (figure 176).

Of the sense organs only the eyes and the trichobothria are more or less regularly visible. The latter are difficult to photograph on account of the extreme smallness of their diameter. When, however, as in the case shown in figure 180 the entire surface of the trichobothrium is covered with little crystals, photography is comparatively simple. In this particular case the greatest difficulty was in bringing into focus the entire trichobothrium. For this purpose I had to tilt the slide under microscope until both ends of the trichobothrium appeared sharply outlined, the rest being taken care of by the stopping down of the diaphragm.

Twenty families are represented in the collection, one of them a new one — EPHALMATORIDAE, and one, Dictynidae, for the first time described from amber. *Archaea hyperoptica* Menge, *Nactodipoena infulata* (Koch and Berendt) and *Linyphia oblonga* Koch and Berendt represented each by one specimen, have been described in detail. Five new genera are proposed, Eolathys, Ephalmator, Eostaianus, Fiducia and Eothanatus. One Recent genus, Harpactes, not previously known from the amber, is now recorded for the first time, represented by a single, new species. Seventeen new species are described in detail and figured.

To facilitate the use of the present paper by paleontologists who are not familiar with my papers dealing with the classification of Recent spiders I may state that the arrangement and the numbering of the families is in agreement with the one used in my Catalogue of

American Spiders. Since strictly fossil families are omitted from that Catalogue, the new fossil Family Ephalmatoridae appears here without a number.

It gives me great pleasure to express my thanks to Professor F. M. Carpenter of Harvard University for the privilege of studying this extremely interesting collection, and his patience with the slow progress of my work.

## 13 Family UROCTEIDAE

### Genus PARUROCTEA Petrunkevitch 1942

Type *P. blauvelti* Petrunkevitch

#### PARUROCTEA BLAUVELTI Petrunkevitch

Figures 1–3, 174 and 186

*Paruroctea blauvelti* Petrunkevitch, Trans. Conn. Acad., 1942, Vol. 34, p. 193, Figures 465 to 469 and 618. Type. Cornell University. Mus. Comp. Zoöl., Harvard, Specimen 7127 (3617)

The present specimen belonging to the Mus. Comp. Zoölogy, although three times smaller than the type, belongs to the same species. It has the advantage over the type in that the sternum is completely and clearly visible and the dorsal wall of the abdomen, missing in the type, is also preserved. The specimen is only 1.1 mm. long. It is shown in Figure 186 photographically with all its legs as viewed from above. Figure 1 shows at a somewhat higher magnification the carapace and abdomen. On the carapace the eye group is visible, but the individual eyes are very difficult to see and only their outer edge shows in certain positions of the illuminating ray. There is a stout bristle between the anterior median eyes, a pair of much finer bristles are situated in front of the posterior median eyes, while behind the eye group two bristles, one behind the other, are situated in the plane of symmetry. The eye group is transversely elliptic, 0.14 mm. long, 0.21 mm. wide.

The sternum of the type was figured by me with a rounded posterior edge (1942, figure 466), but in the text I left the question open as to the true shape of its posterior edge—"the presence of an air-bubble prevents a clear view of the posterior end of the sternum, so that it is impossible to decide whether the posterior edge is rounded or ends in

a short point." (p. 194). The specimen of the Museum of Comparative Zoölogy shows the sternum clearly and its outline may be followed without difficulty under microscope. It is shown in Figure 2 at a magnification of 55 X. Its anterior edge is straight, its posterior edge is not rounded, but drawn out into a blunt point projecting between the fourth coxae. The length of the sternum is a fraction shorter than the width, the former being 0.41 mm. and the latter 0.42 mm. But since the sternum, like the rest of the spider is distorted, it is difficult to say whether in its normal condition it was as long as wide or slightly wider than long. At any rate the difference must have been very insignificant and well within the limits of possible variation.

The legs are as in the type, and such small differences as may be noticed are of no great importance. They may be attributed to the difference in the instar. The claws shown in Figure 3, as they appear on the third left leg under a magnification of X 275, are somewhat more slender than in the type, but resemble the latter in their general structure. There are no serrated bristles and no spurious claws.

The abdomen is very well preserved. It is evenly rounded at both ends and its outline is an almost perfect ellipse. (Figure 1). Its dorsal surface is clothed with curved, widely spaced, coarse hairs shown in the drawing only around the edge so as not to obstruct the view of the inner organs. The spinnerets and the anal tubercle are as in the type and characteristic of the family. The tuft or crown of long, diverging hairs at the end of the anal tubercle is plainly visible. What makes this specimen unique among Baltic Amber spiders is the preservation of the "liver" (chylenteron), ovary and heart. To be sure, the preservation is not perfect and the shrinkage of the visceral mass and its loosening from the abdominal wall caused considerable displacement from the original position of the organs. But they are plainly recognizable and look very much as in Recent spiderlings which are mounted in toto in dammar. In the chylenteron subdivisions can be seen, but their number cannot be determined. Their general appearance is coarsely granular, of a light yellowish-brown color. In the ovary about 18 immature eggs can be counted, more or less evenly separated and of much darker, reddish brown color. The heart is transparent and colorless, but its outline is quite sharp (Figures 1 and 174) and three pairs of projections can be seen, corresponding to the cardiac auricles of Recent spiders and presumably containing the ostia. The ostia, however, cannot be seen and their number may be only assumed to be three pairs by analogy with similar pictures of the heart in Recent spiders.

The specimen is undoubtedly a very young female.

## 17 Family ARCHAEIDAE

### Genus ARCHAEA Koch and Berendt 1854

Type *A. paradoxa* Koch and Berendt

A key to the species of Archaea will be found in my Study of Amber Spiders, published in 1942. That key was based on characters given by Koch and supplemented by Menge, on Simon's description of his *A. pugneti* and on my own study of the female, now hypotype, in the collection of the British Museum. The collection of the Museum of Comparative Zoölogy contains two specimens of *Archaea paradoxa* and one specimen of *A. hyperoptica* of which I give here a detailed description with figures.

#### ARCHAEA HYPEROPTICA Menge

Figures 4–10 and 187

*Archaea hyperoptica*, Koch and Berendt, 1854, p. 22. Hypotype in Mus. Comp. Zoöl., specimen No. 7148 (129)

Menge did not give a figure of his species and his description is so brief that it would be almost useless were it not for the mention of the single character by which *A. hyperoptica* may be distinguished from all the other species of the genus, and which it shares only with the South African Recent *A. godfreyi* Hewitt. Following is a complete quotation of Menge's description: "Kopftheil erhöht, halbkugelförmig, hinten allmälig ohne deutlichen Absatz (was also in den Gattungsmerkmalen zu streichen wäre) in das ansteigende Rückenschild übergehend. Stirn und Gesicht ziemlich flach. Augen wenig erhöht. Hinterleib durch ein dünnes Stielchen von der Brust getrennt, eiförmig, fast kugelig, parallelfurchig und behaart. Spinnwarzen über den Afterring vorragend. Kiefer mässig lang, Füsse mit gekrümmten Härchen dicht besetzt." The absence of a break (Absatz) between the head and the thorax clearly separates *A. hyperoptica* from *A. godfreyi* to which it has the greatest affinity, for although the latter also has no neck, it shows a deep indentation separating the head from the thorax and clearly shown in Hewitt's figure. The Museum of Comparative Zoölogy has a single specimen undoubtedly devoid of all visible separation between the head and the thorax and therefore, in this respect, fully agreeing with Menge's statement. It is an immature specimen in very clear amber and complete but for the right metatarsus and tarsus of the first pair of legs. The specimen may be, therefore, regarded as a hypotype.

*Description of the hypotype.* (Figures 4–10 and 187). Total length without chelicerae 1.75 mm. Carapace 0.70 mm. long, 0.35 mm. wide, 0.45 mm. high, just behind the eyes, sloping gradually almost in a straight line backwards, without the slightest indication of the limits of the head. No sculpturing is visible either on the back or on the sides of the carapace, comparable to what one sees in *A. paradoxa.* The face is distinctly concave. The cheliceral foramen through which the chelicerae project, is neatly transversely elliptic. Above the chelicerae the carapace appears as a distinctly swollen ridge or transverse welt slightly wider than the anterior eyes. The eyes themselves are difficult to see. They become visible only when the background is left dark and a narrow beam of strong light directed at a certain angle penetrates below the surface of the carapace. Under these conditions measurement is impossible, but one can see that the anterior median eyes are separated from each other by something like four of their diameters and by only about their diameter from the anterior lateral eyes. The four posterior eyes are still more difficult to see. They are considerably smaller and seem to be placed in a line parallel to that of the anterior row.

The first joint of the chelicerae is 0.65 mm. long. It has a peculiar shape, slightly stouter in the middle than at both ends and bent downwards as shown in figures 8 and 187. Viewed from in front the outer edges appear fairly straight and gradually diverging, while the inner edges are more or less parallel in their basal half, only to begin suddenly diverging from here on as shown in figure 9. A row of about eleven stiff bristles can be seen on the inner edge, the first a little before the middle. The fangs are slender, curved and pointed. The maxillae (figure 7) are long, curved and converging almost to contact with each other in front of the lip which is also unusually long, extending far beyond the middle of the maxillae. In side view (figure 10) the lip presents a distinct dip near its end. The sternum is flat, much longer than wide, truncated at both ends and widest between the first and second coxae. The first pair of coxae is widest apart, the fourth pair is sub-contiguous.

| Legs | Femur | Pat.+Tibia | Metatarsus | Tarsus | Total |
|---|---|---|---|---|---|
| I | 1.25 | 1.15 | 0.50 | 0.30 | 3.20 |
| II | 1.10 | 1.05 | 0.50 | 0.30 | 2.95 |
| III | 0.75 | 0.40 | 0.20 | 0.15 | 1.50 |
| IV | 1.05 | 0.80 | 0.40 | 0.30 | 2.55 |

| Leg formula | 1 | 2 | 4 | 3 |
|---|---|---|---|---|
| | 4.5 | 4.2 | 3.6 | 2.1 |

There are no spines on the legs, but all joints are clothed with short, curved hair which appears to be simple under low magnification,

but is in reality finely serrated when examined under high power. The tarsi end with a very distinct onychium (figure 6) but the claws are difficult to see. In one leg only, in which only an upper claw is visible, it shows two teeth, the distal one of considerable length and easily mistaken for the end of the other upper claw. The femur and trochanter of the palpi (figure 4) have a ventral row of peculiar organs which may have been either short spines elevated on pedestals, or else sensory hairs of a different function from that of trichobothria. The latter may be seen on all metatarsi under high power, a single one a little beyond the middle of the joint.

The abdomen is 0.75 mm. long without spinnerets, 0.60 mm. high, 0.50 mm. wide. When viewed from above (figure 5) it appears to be symmetrically ellipsoidal, but when examined in side view (figure 8) shows an almost flat ventral surface and its middorsal line is evenly curved. The sides show a series of parallel corrugations which however are not deep, as in *A. paradoxa*, but so shallow that they become clearly visible only under special conditions of lighting. Then one can see that these rows of parallel corrugations occupy the entire side.

## 19 Family MIMETIDAE

### Genus ERO C. L. Koch 1837

Type *E. tuberculata* (DeGeer)

Koch described two species, *E. setulosa* and *E. sphaerica*, but expressed the opinion that the latter may be the same species as the former, but of different sex. Menge added in a footnote, that Koch made a mistake in observation and that both specimens are immature males. Menge himself added the names of three species from his own collection, but never gave either a description or figures of them. They are therefore *nomina nuda*. I described two species. If Koch's statement is correct we may separate his species from mine by the relative size of the eyes.

1. All eyes of the same size ..... *E. setulosa*
   AME larger than the other eyes ..... 2
2. Sternum but slightly longer than wide and not very prominent. Eyes not conspicuously protruding beyond sides of head. Palp as figured ..... *E. permunda*
   Sternum distinctly longer than wide (5:4), very convex. Eyes strongly protruding. Palp as figured ..... *E. carboneana*

### Ero permunda Petrunkevitch

One badly mishandled specimen in the collection of the Museum of Comparative Zoölogy (1289). It is an immature female, which makes it interesting notwithstanding its poor condition, caused by polishing off the left side and partly filling the cavity with the polishing white powder. The sternum being only little longer than wide and not very convex, and the eyes not greatly protruding, the species seems to be recognizable notwithstanding differences in other characters which may be easily explained as of secondary sexual origin.

Total length 2.14 mm. Carapace 1.25 mm. long. Its width cannot be measured. Abdomen neatly ellipsoidal, 1.15 mm. long, overhanging the carapace.

| Legs | Femur | Pat.+Tibia | Metatarsus | Tarsus | Total |
|---|---|---|---|---|---|
| I | 1.65 | 1.70 | 1.25 | 0.85 | 5.45 |
| II | 1.45 | 1.40 | 0.95 | 0.75 | 4.55 |
| III | 0.90 | 0.90 | 0.55 | 0.45 | 2.80 |
| IV | 1.20 | 1.15 | 0.90 | 0.55 | 3.30 |

| Leg formula | 1 | 2 | 4 | 3 |
|---|---|---|---|---|
| | 4.3 | 3.6 | 2.6 | 2.2 |

The spines are rather difficult to describe. But the typical spines of the tibia and metatarsus of the first and second leg are well visible. On the first tibia there are only six long spines, with only two short spines between them in all intervals. On the first metatarsus only four long spines, the first immediately at the beginning of the joint, the fourth separated from the end of the metatarsus by a row of six short spines. The long spines on the second leg are not as long as those on the first.

## 21 Family DICTYNIDAE

### Genus Eolathys, new

Sternum produced posteriorly. Cribellum entire. Calamistrum with a single row of curved hairs, occupying about three fifths of the segment. All femora with a middorsal spine. The fourth metatarsus with a subapical dorsal and a pair of weak subapical ventral spines. All tarsi without trichobothria. Anterior eyes all of the same size, but the median pair slightly closer together. Posterior eyes about evenly spaced in a procurved line which is longer than the first line

and the lateral eyes separated by almost their diameter. Upper claws similar, with a row of about eight or nine teeth. Third claw with a long single tooth. (Maxillae not visible). Armature of chelicerae consists of a single, small tooth on promargin near base of fang. Retromargin with several fine bristles. Type *E. succini* spec. nov.

### Eolathys succini spec. nov.

Figures 11–18, 183 and 184

A well preserved specimen (No. 7453), almost all structures of which can be seen, provided one studies it in mineral oil and changes the position of the specimen and the angle of incident light to avoid reflections from planes of stress.

Total length 2.95 mm. Carapace 1.12 mm. long, 1.05 mm. wide between second and third coxae. The head which is clearly marked by the cephalic sulci is only 0.51 mm. wide and the lateral angle between the head and the thorax is really angular and not rounded. The shape of the carapace can be understood best from an examination of its dorsal and lateral view (figures 11 and 18). It will be seen that the highest point of the thoracic portion is as high as that of the head, so that in the line of the plane of symmetry there is no dip between the two. The posterior declivity is steep and the thoracic portion of the carapace is with a double margin along its entire edge. Since the specimen is immature, it may be that the effect is due to the presence of the newly formed carapace under the still present old one. The surface of the entire carapace is sparsely clothed with simple, short hair. The eye group seems to be as wide as the head, but it is difficult to get a view of the edge of the carapace simultaneously with the eyes. The eyes are all more or less of the same size, perhaps the eyes of the second row slightly larger. Measurements are very unsatisfactory. The AME are somewhat closer together than their diameter and are separated from the ALE by their diameter (figure 15). The second row is distinctly procurved, the eyes are equidistant and the quadrangle of medians is much wider behind than in front and a little wider than long.

The chelicerae are stout and short, with parallel outer edges. The fang is curved and slender. The promargin has a small tooth close to the base of the fang, followed by a minute granule. The retromargin has no teeth, but is provided with a scant scopula composed of a single row of a few slender bristles. The maxillae and the lip cannot be seen in any position on account of white emulsion. The sternum and the coxae are very well visible (figure 14). The sternum is almost typi-

cally heart-shaped, with a small posterior process separating the fourth coxae. The surface of the sternum is fairly flat and sparsely clothed with short, simple hair directed forward. The first coxae are wide apart.

| Legs | Femur | Pat.+Tibia | Metatarsus | Tarsus | Total |
|---|---|---|---|---|---|
| I | 0.80 | 1.00 | 0.60 | 0.40 | 2.80 |
| II | 0.75 | 0.80 | 0.45 | 0.35 | 2.35 |
| III | 0.70 | 0.65 | 0.45 | 0.35 | 2.15 |
| IV | 0.75 | 0.90 | 0.60 | 0.40 | 2.65 |

| Leg formula | 1 | 4 | 2 | 3 |
|---|---|---|---|---|
| | 2.5 | 2.4 | 2.1 | 1.9 |

The calamistrum is shown in figure 12. It is plainly visible, occupies the largest portion of the metatarsus and consists of a single row of curved hairs. The three distal hairs longer and farther apart than the rest, and in front of the last and longest hair there stands a stout spine. A pair of slender, ventral spines can be seen on the ventral surface of the fourth metatarsus, not far from its end. There is also a dorsal spine present in the middle of each femur, but no other spines can be seen on any leg. The upper claws are similar and pectinate in a single row with about nine slender teeth. The third claw is long and has a single long tooth (figure 13). There are no trichobothria on any tarsi and I am unable to see any either on the metatarsi or the tibiae.

The abdomen is almost perfectly ellipsoidal, 1.85 mm. long, 1.25 mm. wide, overlapping the carapace as shown in figure 11. It is clothed with short, simple hair; bristles are wanting. The spinnerets are plainly visible. The anterior pair is somewhat stouter and longer than the posterior pair (figure 17). The median pair is considerably shorter (figure 12). The cribellum is entire, trapeze-shaped, wider in front than behind. No epigynum can be seen and it is probable that the specimen is immature. The palp is of the female type. Whether a palpal claw is present or wanting cannot be ascertained. Recent species always have a claw.

### Eolathys debilis spec. nov.

Figures 19–24, and 182

Type, a mature female, 7641 b (2984) figure 182. The specimen is in almost clear amber, but with a dirty plane of cleavage passing at an angle obliquely across the back of the spider. Evidently the creature was caught in fluid resin and partly submerged. The exposed

surface was covered with dust and then a new layer of clear amber resin covered the rest of the spider. As a consequence one gets a clear picture of the major portion of the body from the underside and an equally clear picture of the smaller portion of the body from above, but in no position can the complete body be seen. Part of the ventral surface, especially the spinnerets, are poorly visible on account of a white emulsion coating them. In addition, the chitin of the thorax is preserved as such, but the chitin of the head disintegrated, leaving a crystal clear mold of the outside, the details of which, such as the eyes, are extremely difficult to see and then only in certain positions of the piece and never all eight eyes at the same time. That is the reason why it was necessary to make the picture of the eye group without the aid of a camera lucida, by changing the position of the piece many times to obtain a complete idea of the disposition of the eyes. Measurements, of course, are under the circumstances quite out of the question. The cribellum is not visible. The calamistrum is very difficult to see and is visible on both legs only in a certain position different for each of the two legs.

Total length 2.29 mm. Carapace 0.95 mm. long, 0.65 mm. wide.

| Legs | Femur | Pat.+Tibia | Metatarsus | Tarsus | Total |
|---|---|---|---|---|---|
| I | 0.70 | 0.75 | 0.50 | 0.40 | 2.35 |
| II | 0.55 | 0.60 | 0.45 | 0.30 | 1.90 |
| III | 0.55 | 0.55 | 0.45 | 0.30 | 1.85 |
| IV | 0.70 | 0.80 | 0.60 | 0.35 | 2.45 |

| Leg formula | 4 | 1 | 2 | 3 |
|---|---|---|---|---|
| | 2.6 | 2.5 | 2.0 | 1.9 |

The carapace is fairly high and clothed with hair directed forward. The eye group is not as wide as the head. The anterior row seems to be straight and shorter than the rather strongly procurved posterior row (figure 20). The chelicerae are parallel, stout and distinctly geniculated in front. Their anterior surface is clothed with stout, but sparse hair. The margins are oblique and one can see, by examining them through the body from behind, four small, but distinct teeth on the retromargin and a scopula of some four or five long hairs on the promargin (figure 19). The sterno-coxal region is shown in figure 24. The sternum is flat, typically heart shaped, slightly longer than wide. Posteriorly the sternum is drawn out into a distinct projection between the hind coxae. The first coxae are wide apart. The spination of the legs is the same as in the genotype, but the claws (figure 22) differ from those of the genotype. The upper claws have fewer teeth and the third claw is smooth. The calamistrum (figure 23) is very much as in the genotype but for some reason is much more difficult

to see. The spinnerets can be seen only in a side view when the strong beam of light is so directed that it penetrates the white emulsion. Then it becomes apparent that they are of the same general type as in *E. succini* and that the anterior pair are widely separated at base and inclined toward each other. The epigynum is shown in figure 21.

The two species of Eolathys may be recognized by the difference in their leg formula.

## 22 Family ERIGONIDAE

### Genus EOGONATIUM Petrunkevitch 1942

Type *E. minutum* Petrunkevitch

#### EOGONATIUM SUCCINI Petrunkevitch

*Eogonatium succini* Petrunkevitch, 1942, p. 211, figures 289, 333 to 337 and 595.

One female, 7439. It shows clearly the elevated head. The epigynum is fully developed and of the figured type, but the tip of the scape is truncated. On the basis of this character alone it would be unreasonable to create a new species as the other characters conform with the type.

## 26 Family AMAUROBIIDAE

### Genus AUXIMUS Simon 1892

Type *A. dentichelis* Simon

#### AUXIMUS FOSSILIS spec. nov.

Figures 25–28, and 185

*Type.* Female. Possibly immature. No. 7030. (Figure 185.) Museum of Comparative Zoölogy. The dorsal surface of the specimen is well preserved and clearly visible, the ventral surface covered with a thick coating of white emulsion obstructing the view of the mouthparts, sternum, epigynal region and spinnerets with cribellum. The legs are all complete, the claws are visible on several tarsi. The calamistrum is in plain view on the fourth left metatarsus, when the specimen is examined from below (viewed from above the calamis-

trum is hidden under the abdomen.) The appearance of the species resembles that of *A. succini* and is easily confused with the latter. However, it is easily distinguished by the greater number of teeth on the upper claws and the relatively shorter legs (by reference to the length of the carapace). The two amber species may be therefore distinguished as follows:

a) Upper claws with a row of six teeth.

| Leg formula | 1 | 4 | 2 | 3 | *A. succini Petr.* |
|---|---|---|---|---|---|
| | 3.1 | 2.9 | 2.7 | 2.5 | |

b) Upper claws with a row of 11 or 12 teeth.

| Leg formula | 1 | 4 | 2 | 3 | *A. fossilis*, new |
|---|---|---|---|---|---|
| | 2.4 | 1.9 | 1.8 | 1.4 | |

The general appearance of the new species may be best understood from figure 25 and photograph, figure 185.

Total length ca. 6.00 mm. Carapace 2.71 mm. long, 1.43 mm. wide in front, 1.86 mm. wide in its widest place, showing that the head is unusually wide. Although generally speaking the head is high, it is on a level with the thoracic portion without any noticeable dip between the two. The highest point is more or less in a line with the first pair of coxae. The eye group is only 0.86 mm. wide, that is much narrower than the width of the head. The first row of eyes (figure 27) is shorter than the second. The AME are small and contiguous. Next in size are the PME which are separated from each other by almost two of their diameters, thus making the quadrangle of medians much wider behind than in front. The lateral eyes are much the largest. They are contiguous. The four posterior eyes are about equidistant. The clypeus is very low. The head is sparsely clothed with simple hair directed forward. The individual hairs are separated by intervals which are some five or six times greater than the thickness of a hair. The thoracic portion is free from hair, except for a pair of rows beginning at the point where the head ends, diverging and outlining the posterior declivity. Each of the two rows is composed of only about half a dozen short hairs.

| Legs | Femur | Pat.+Tibia | Metatarsus | Tarsus | Total |
|---|---|---|---|---|---|
| I | 2.00 | 2.25 | 1.35 | 0.90 | 6.50 |
| II | 1.50 | 1.65 | 1.10 | 0.70 | 4.95 |
| III | 1.30 | 1.40 | 0.65 | 0.60 | 3.95 |
| IV | 1.55 | 1.60 | 1.30 | 0.70 | 5.15 |

The calamistrum (figure 26) consists of a single row of curved hairs. It begins about one sixth of the total length of the metatarsus from

the proximal end and ends about two sixths before its distal end. In other words the calamistrum is only half as long as the metatarsus.

The spines are short, but can be seen plainly where the white emulsion does not obstruct their view. There is a dorsal spine present on the first and second femur approximately in its middle. No corresponding spine seems to be present on either the third or the fourth femur. A prolateral and a retrolateral spine is present on the first and second patella, but only a retrolateral spine on the third and fourth patella. On the first tibia one can see 1–1–1 prolateral spines and 0–0–1 retrolateral. On the second tibia 1–1–1 prolateral and 1–1–1 retrolateral spines. Whether ventral spines are present cannot be ascertained. On the metatarsus one can see 2–2–2 ventral and 1–0–1 prolateral spines.

The claws are plainly visible on the first left leg and can be studied under high power from both sides of the slide. The upper claws are similar (figure 28) evenly curved and provided with a row of 12 teeth. The third claw is also evenly curved and has two small teeth.

The abdomen is 3.29 mm. long, 2.71 mm. wide, evenly rounded at both ends, somewhat flattened above. While its shape is well preserved, nothing else can be seen and even the hair, if any is present, cannot be made out. The hair on the legs, on the other hand is plainly visible through the emulsion and is short and stout, giving it a spinose appearance.

*Paratype*. 7648. Probably immature female. Ventral surface heavily coated with white emulsion. First pair of legs cut off. Total length 5.15 mm. Carapace 2.15 mm. long, 1.50 mm. wide. In front of the small anterior median eyes there is a bristle. The clypeus is higher than the diameter of the AME and about as high as the diameter of the ALE. The shape and appearance of the carapace is the same as in the type. It is very dark brown, the hair on it is long, curved and directed forward. The chelicerae are powerful, hirsute and provided with a prominent boss. The fangs are covered by white emulsion. The sternum can be seen, but its outline is not visible. Its surface is flat and clothed with long hairs, directed forward and at a considerable angle to the surface. The spines on the legs are much better visible than in the type and some of them stand almost at right angles, especially the ventral ones on the tibiae. The spination seems to be the same on all legs, namely: femur dorsal 0–1–2; patella prolateral 1, retrolateral 1; tibia prolateral 1–1, retrolateral 1–1, ventral 1r–1r–2; metatarsus prolateral 1–2, retrolateral 1–2, ventral 1r–1r–2 (the six distal spines forming an apical verticellum). The calamistrum can be seen on both legs and is of the same appearance as in type. The claws also conform with the type. The ventral surface of the

abdomen is heavily coated with white emulsion, precluding a view of the spinning group.

A third specimen (7176) is still smaller and must be therefore regarded as an earlier instar. It is only 3.9 mm. long. The cribellum is not visible. The calamistrum can be seen, although not as well preserved as in the other two specimens.

## 27 Family PSECHRIDAE

### Genus EOMATACHIA Petrunkevitch 1942

Type *E. latifrons* Petrunkevitch

#### EOMATACHIA LATIFRONS Petrunkevitch

A single specimen (7223) which is a mature male, rather poorly preserved. Neither the calamistrum nor the cribellum can be seen, the former because of the position of the fourth legs, the latter because of white emulsion obstructing its view. But both palpi show the characteristic tibial apophyses and the identification of the species is beyond any doubt.

## 28 Family AGALENIDAE

### Subfamily AGALENINAE

### Genus EOCRYPHOECA Petrunkevitch 1946

Type, *Tegenaria gracilipes* Koch and Berendt

The Genus Eocryphoeca was erected by me in 1946 for a Baltic amber spider which I referred to Koch's species *gracilipes* and which I declared to be the hypotype and the genotype. The genus is closely related to the Recent genus Cryphoeca from which it differs by relatively longer legs, somewhat different disposition of spines and lesser disparity in the size of the eyes of the anterior row. In the same paper I referred to the Genus Eocryphoeca a species which I described in 1942 under the generic name of Myro, namely *M. fossilis*. The genus Myro belongs to the Subfamily Cybaeinae which Simon erected for the inclusion of Agalenidae with spinnerets resembling those of Clubionidae. However, the shape of the spinnerets is not always easily recognizable in amber spiders. Taking the combination of all

characters under consideration the two above species seem to be congeneric. Now a third species described below must be added, since it agrees with them in several important characters. The three species may be distinguished one from another as follows:

1. Anterior median eyes distinctly smaller than the lateral eyes . . . . . 2
– Anterior median eyes of the same size with the other eyes. Eyes of first row contiguous . . . . . *E. distincta*, n. sp.
2. Quadrangle of median eyes almost twice as wide behind as in front. Eyes of second row separated by slightly less than their radius. Posterior median eyes as large as posterior lateral eyes . . . . . *E. gracilipes* (Koch and Berendt)
- Quadrangle only a little wider behind than in front. Eyes of second row separated by about their diameter. Posterior median eyes distinctly smaller than posterior lateral eyes . . . . . *E. fossilis* (Petrunkevitch)

An additional interesting character of the new species is the lack of plumose hair so characteristic of all Recent Agalenidae.

### Eocryphoeca gracilipes (Koch and Berendt)

*Tegenaria gracilipes* Koch and Berendt, 1854, p. 47, pl. xvi, fig. 139.
*Eocryphoeca gracilipes*, Petrunkevitch, Amer. Mus. Novit., No. 1328, 1946, p. 4, figs. 11–21, 78.

The Museum of Comparative Zoölogy has a specimen No. 6803 which I refer without hesitation to this species. It is an exuvium, but one in excellent preservation permitting the recognition of all important characters. What is of great interest, however, is the fact that the exuvium is preserved with its web in which it must have been suspended by the spider as usual to make molting easier. It seems quite certain that the web belongs to this individual spider, for there are no signs of distortion or damage to the web. Presumably it was attached to some dead plant, a portion of which bearing the web was then dropped from above or blown by the wind against a drop of fluid resin and thus preserved in its normal shape. Most of the hypothetical plant must have been cut or broken off long before the piece was purchased by the Museum, but a small triangular piece which may be a piece of a leaf is still remaining in the amber. The silk is of the simple variety, not viscid, some threads are quite thin, others are held together forming fairly stout cables. The web lies in two planes intersecting each other at almost right angles, but in the preparation of the photograph shown in figure 179 only one plane was brought into focus and the objective (Apochromat 16) was purposely

used at its maximum numerical aperture. This gives a better idea of the actual structure of the web in one of its planes. It is very different from that of Recent Agalenidae of the genera Agalena and Tegenaria. Unfortunately at this moment I do not have a sample of a web of a Recent Cryphoeca and can find no figure of it for comparison.

### Eocryphoeca distincta spec. nov.

Figures 40–49 and 198

*Type*, No. 7751. A mature female, a well preserved specimen which, however, shows some peculiarities. The tips of three legs are missing, the end of one palp is broken off and shifted a little forward in the amber, the sternum is also missing and its place is filled with white emulsion, and several portions of the chitinous skeleton seem to be carbonized. It gives the impression as if the specimen was dead when it was caught in the resin and remained partially exposed to the air before being completely engulfed. Nevertheless the preservation is excellent and some structures can be seen which were less distinct in the types of *E. fossilis* and *E. gracilipes*.

Total length 4.2 mm. Carapace 1.85 mm. long, 1.40 mm. wide between second and third coxae. Head with parallel sides, 0.82 mm. wide. Eye group 0.57 mm. wide, with second row of eyes slightly wider than the first row. The carapace is flat, with head and thorax on the same level and posterior declivity gentle. Thoracic groove longitudinal. Cephalothoracic sulci clearly visible (figure 40). The carapace is very sparsely clothed with simple hair. The eye group (figure 41) is difficult to study on account of the black color of the carapace and eyes. The first row is well visible from above and shows clearly that all its eyes are contiguous and of about the same size. The eyes of the second row are also of about the same size, though it is possible that the posterior lateral eyes are just a little larger than the posterior median eyes which are very difficult to see and to measure. The quadrangle is a little wider behind than in front and a little wider than long in the same ratio of 25 : 22. Looked at from above the posterior row is so slightly procurved that it may be said to be straight. Looked at from in front the anterior row is very little downcurved and the clypeus is ca. as high as the diameter of the eyes.

The chelicerae are short and not geniculated. They are altogether invisible from above, nor can they be studied from below on account of dirt in the amber, which hides also the maxillae and lip. The sternum is missing as stated above. The fourth left coxa is broken across and its mesial end is missing.

| Legs | Femur | Pat.+Tibia | Metatarsus | Tarsus | Total |
|---|---|---|---|---|---|
| I | 1.70 | 2.10 | 1.45 | 1.00 | 6.25 |
| II | 1.55 | 1.75 | 1.35 | 0.85 | 5.50 |
| III | 1.40 | 1.65 | 1.35 | 0.50 | 4.90 |
| IV | 1.70 | 1.70 | 2.00 | 0.60 | 6.00 |
| Palp | 0.75 | 0.62 | 0.67 | | 2.04 |

| Leg formula | 1 | 4 | 2 | 3 |
|---|---|---|---|---|
| | 3.4 | 3.2 | 3.0 | 2.6 |

The general proportion of the legs may be seen in the photograph (figure 198), but to make it still easier to appreciate, figure 40 was drawn to scale with all legs arranged in the conventional manner. The legs are distinctly spinose and the spines are long and stout. Figure 45 gives an idea of their appearance compared with the segment — in this case the metatarsus — to which they belong. The arrangement of the spines is as follows. First leg, femur dorsal 1–1–1, prolateral 0–1–1, retrolateral 0–0–1. Patella dorsal 1–1. Tibia ventral 2–2–0, metatarsus ventral 2–2–2. No other spines. Second leg same as first. Third leg cannot be studied satisfactorily. Fourth leg, femur dorsal 1–1–2, patella dorsal 1–1 bristles, retrolateral 1–1 (the first a spine, the second a bristle). Tibia dorsal 1–1, prolateral 1–1, retrolateral 1–1, ventral 2–2–2. Metatarsus dorsal 1–1–1, prolateral 1–1–1, retrolateral 1–1–1, ventral 2–2–2. The upper claws are similar, with a row of 10 or 11 teeth, the third claw with 2 or 3 teeth (figure 43). There are no serrated bristles, no plumose hair on the legs. The trichobothria are long and fine, especially on the metatarsi (figure 44). On the tarsi they increase in length distally and are in a single row.

The abdomen, heavily coated above with white emulsion, is 2.5 mm. long, 1.85 mm. wide in its posterior third as shown in figure 40. Anteriorly it overlaps the posterior edge of the carapace. Its dorsal surface is sparsely clothed with long, stout, dark hairs protruding through the emulsion. The ventral surface is sparsely clothed with much shorter hair which is so stout that in places it has the appearance of rods. Both surfaces of the abdomen are flat. The spinnerets are plainly visible and are shown in figure 42. The anterior pair are cylindrical with a very short second joint. At base they are separated by more than their width. The median pair are small, single-jointed and very hairy in appearance. They are separated by almost their width. The posterior pair are much more slender than the anterior pair and their first joint is as long as the entire anterior spinneret. Their second joint is cone-shaped and considerably shorter than the first joint. They are wider apart than the anterior pair and the four spinnerets form therefore with their bases a trapeze which is wider behind than in front.

The spinning tubes can be seen in strong light, but naturally only

those which are visible from below. There seem to be four types of them. On the anterior spinnerets (figure 48) the spinning tubes are short and have short ends. On the median spinnerets (figure 47) one can see four tubes with long, cylindrical base and relatively short end, and two very large cone-shaped spigots. On the posterior spinnerets (figure 46) one cone-shaped spigot may be seen at the very end of the second joint, and four small tubes with long ends. The epigynum itself cannot be seen on account of some obstruction in that region. But in front of the genital fold a flat, more or less diamond-shaped (figure 49) swelling is plainly visible, corresponding to a similar swelling in Recent mature females.

## Subfamily CYBAEINAE

### Genus MYRO Cambridge 1876

Type *M. kerguelenensis* Cambridge

### MYRO HIRSUTUS Petrunkevitch

Figures 29–39, and 197

*Myro hirsutus* Petrunkevitch, 1942, p. 231, figs. 308–311, and 601.

This species was described by me on the basis of a very poorly preserved specimen contained in a piece of imperfect and very dark amber. Many important characters could not be seen in the type, still less could they be drawn with the aid of a camera lucida even when discernible in a beam of strong light. For this reason it seems advisable to give here a detailed description and a number of drawings of different structures visible in the specimen belonging to the Museum of Comparative Zoölogy because of its excellent preservation in almost perfectly clear amber.

Mature male (figures 29–39, and 197). Total length with chelicerae 4.6 mm. General appearance best understood from an examination of figure 197 which is a photograph made on a panchromatic plate with a light red ray filter. Many parts of the specimen are almost pitch black. A bubble of air is enclosed in the abdomen and had to be left there since nothing but drilling would have made its removal possible. This was unnecessary, because the bubble did not obstruct the view of any important character. The legs are so flexed that only the anterior quarter of the carapace is visible and a drawing of the entire carapace is impossible except as a restoration on the basis of

measurements and of examination of the specimen in different positions. One can see the left edge as a line interrupted by the femora, when one inclines the specimen so that its left side is distinctly raised. Similarly one can see the right edge of the carapace by turning the specimen on its back. A short piece of the posterior edge just across the petiolus can be seen from above, permitting exact measurement of the length of the carapace. The eye group is elevated above the sides of the head, but the elevation cannot be called a tubercle, because it extends apparently to the end of the head, gradually descending to the level of the carapace at the point where the head ends and the thoracic portion begins. The carapace is 1.85 mm. long, ca. 1.1 mm. wide between second and third coxae (exact measurement impossible), 0.90 mm. wide in front view of the face. The eye group is only 0.40 mm. wide, i.e. less than half the width of the head. Viewed from above (figure 30 and 32) the first row of eyes is almost straight, the second row strongly procurved. The quadrangle of medians is 0.24 mm. long, 0.12 mm. wide in front, 0.17 mm. wide behind, i.e. it is considerably longer than wide and much narrower in front than behind. The anterior median eyes are the smallest and have a diameter of 0.06 mm. Next come the posterior median eyes with a diameter of 0.07 mm. The lateral eyes are equal and continuous, with a diameter of 0.09 mm. A very stout and long bristle stands in front of the median eyes as shown in figure 31. (In figure 32 only the base of the bristle is shown, because the bristle is much longer than the quadrangle.) Viewed from in front, the first row of eyes is distinctly downcurved. The clypeus, measured from the anterior edge of the carapace to the anterior (lower) edge of the AME is 0.12 mm. high, but if measured only to the edge of the ocular elevation is 0.07 mm. The surface of the carapace is clothed quite sparsely with fairly long and stout hair.

The chelicerae are black, stout, somewhat bulging in front, with more or less parallel sides and transverse margins. The armature of the latter is not visible. The fang seems to be little curved and rather short. A boss is wanting. The front surface of the chelicerae is covered with long, stout, dark brown, curved hairs.

The sterno-coxal region is plainly visible (figure 29). The lip is flat, black, evenly rounded on the sides and in front, transversely truncated behind. Its width at base is exactly the same as that of the sternum, so that the outline of the latter is in direct continuation with the edge of the lip, together forming a neat, elongated oval. Measured alone, as is customary in arachnology, the sternum still is considerably longer than wide, being 0.9 mm. long and 0.7 mm. wide. It is quite convex in a transverse section and becomes convex in a longitudinal section as it reaches the second pair of coxae. From here

on backwards it also shows a series of slight, transverse corrugations. Its color is dark reddish brown and its surface is very sparsely clothed with long hair. The first pair of coxae is wide apart, the fourth pair contiguous and larger than the others. The lip is black and much wider than long, but the exact measurement of its length is difficult on account of dirt at its end. The maxillae are also black and quite peculiar in shape (figure 29). They converge over the lip and are separated in front only by a thick, brown scopula. Anteriorly the maxillae form an almost transverse line with a rounded external angle. The insertion of the trochanter is indicated by short black lines in the drawing.

| Legs | Femur | Pat.+Tibia | Metatarsus | Tarsus | Total |
|---|---|---|---|---|---|
| I | 1.15 | 1.25 | 0.85 | 0.60 | 3.85 |
| II | 0.95 | 1.10 | 0.85 | 0.55 | 3.45 |
| III | 0.90 | 0.90 | 0.75 | 0.45 | 3.00 |
| IV | 1.15 | 1.50 | 0.90 | 0.50 | 4.05 |

| Leg formula | 4 | 1 | 2 | 3 |
|---|---|---|---|---|
| | 2.1 | 2.0 | 1.8 | 1.6 |

These measurements are probably more exact than those I gave for the type, because of the peculiar shape of the piece in which the latter is enclosed, and considering the difficulty of exact measurements under those conditions on account of the relatively great refractive index of amber. But the general agreement is remarkable. The spines are well visible, short, but elevated, giving the legs a rather spiny appearance, although they are numerous only on the last two pairs. First and second leg, tibia dorsal 1–0–1 bristles, ventral 0–1r–1r (the first a bristle, the second a spine). Metatarsus 2–0–2 ventral spines. No other spines on these legs. Third leg patella retrolateral 1, tibia dorsal 1–0–0, prolateral 0–1–1, retrolateral 0–1–1, ventral 0–2–2. Metatarsus retrolateral 1–1–1, ventral 0–2–2. Tarsus ventral 1–1 small spines in midventral line. No other spines on third leg. Fourth leg same as third except tibia dorsal 0–1–0. The presence of two small spines on the third and fourth tarsi is a very unusual character. These spines, however, are no longer than the hair, but being stouter, may be recognized in side view. All legs are rather hairy. The hair is simple. Plumose hair and serrated bristles are wanting. One can see on the first metatarsus 1–1–2 trichobothria and on the first tarsus 2–1 trichobothria. The same appear also on the fourth leg, but the position of the other legs makes their examination for trichobothria uncertain. The third claw is of the same type on all legs, comparatively small, smooth and curved. The upper claws (figures 36–39) show a progressive diminution in the number of teeth from the first leg to

the fourth and a distinct dissimilarity between the pro- and the retroclaw, the former with a greater number of teeth at least on the second and third leg where they can be counted. The first proclaw has about 19 fine teeth, the second proclaw also about 19 fine teeth, while the retroclaw has much stouter and fewer teeth. The third proclaw has 12 teeth, the retroclaw only seven. The upper claws of the fourth leg are similar, each with only six stout teeth. The figures of the claws have been all made at the same magnification and thus give also a good idea of their relative size.

The abdomen is ellipsoidal, 2.4 mm. long, 1.4 mm. wide. It leaves the pedicel clearly visible. The spinnerets are shown in figure 33. They are very difficult to see on account of a film covering them and can be made out only in three quarter view, which makes the anterior pair appear contiguous without a possibility to decide whether that is their actual position or only an effect of examination under an inclined angle of view. One thing is quite certain, namely that they are cylindrical. It seems also to be certain that a colulus is wanting. The surface of the abdomen is clothed with long, standing out hair giving it the hirsute appearance. All hair is simple.

Both palpi are well visible, but quite black. This makes their study very difficult. The retrolateral tibial apophysis is very characteristic and quite blunt and flat, but can be seen only in a position when it does not overlap the surface of the cymbium (figure 35). When the palp is viewed from such an angle that the tibial apophysis comes to lie above the surface of the cymbium, the outline of the apophysis is quite invisible because of the black color of both. The structure of the copulatory apparatus is almost impossible to see for the same reason. It is shown in figure 34 as far as I was able to do it. It certainly is more complex than the figure shows. The cymbium is covered with stout, curved hairs.

The entire specimen is criss-crossed in several directions by threads of silk. No silk is connected with the spinnerets and this makes the assumption that the silk was produced by the specimen in question not quite certain. It is possible that it was already in the resin when the spider was also entangled in it, but the chances are at least equal in the case of either assumption. The threads are composed of several finer ones stuck together, and are of the simple, drag-line type.

## 29 Family PISAURIDAE

### Subfamily THAUMASIINAE

### Genus ESURITOR Petrunkevitch 1942

Type *E. spinipes* Petrunkevitch

This genus was proposed by me for a peculiar spider found in Baltic amber and distinct from Recent species of the same subfamily by the unusual length of its ventral spines on the tibia and metatarsus of the first pair of legs and still more so on the second pair. In this respect *Esuritor* resembles spiders of the sparassid Subfamily Sparianthidinae, but whereas the latter have only two claws and claw tufts, *Esuritor* has three claws and no claw tufts.

#### ESURITOR SPINIPES Petrunkevitch

*Esuritor spinipes* Petrunkevitch, 1942, p. 235, figs. 69–72, 534–535.

The type of this species is in the collection of the British Museum and is an immature female; the paratype is a still younger specimen. Specimen No. 9741 in the collection of the Museum of Comparative Zoölogy is a little smaller than the type. It is 4.7 mm. long. Its carapace is 2.14 mm. long, 1.57 mm. wide, the abdomen 2.57 mm. long, 1.29 mm. wide. Unfortunately the specimen was badly mishandled. All four legs of the left side were polished off and the tip of the right fourth leg is also missing. In addition, part of the head was also polished off leaving only a portion of the eye group intact. The specimen is immature, but there is no doubt of its specific affiliation because all important characters are present and conform with the type.

## 34 Family THERIDIIDAE

### Subfamily LATRODECTINAE

### Genus EODIPOENA Petrunkevitch 1942

Type *E. oculata* Petrunkevitch

#### EODIPOENA OCULATA Petrunkevitch

*Eodipoena oculata* Petrunkevitch, 1942, p. 272, figs. 160–168, and 565; *idem*, 1946, p. 9, figs. 33, 34.

One female, 6899 (548) conforming with every character of the type. The epigynum is covered with white emulsion, but in strong light the outline of it becomes visible.

## Genus NACTODIPOENA Petrunkevitch 1942

Type *N. dunbari* Petrunkevitch

The specimen which is placed here in the genus Nactodipoena as the hypotype of Koch and Berendt's *Micriphantes infulatus* has many resemblances with the genotype as well as with the description and figure of the type of *M. infulatus*. When the carapace is examined from above in the position in which the specimen is in the amber, it looks somewhat like Koch's figure. When the specimen is examined from the dorsal surface with the light so arranged that the lateral edge of the carapace becomes clearly outlined, it resembles the genotype. It resembles the latter also in side view. It is of course impossible to refer the specimen in question with certainty to Koch's species without reexamination of its type. It seems, however, more or less certain that the type specimen perished during the war. Under the circumstances the hypotype should be regarded as the type of this interesting little species.

### NACTODIPOENA INFULATA (Koch and Berendt)

Hypotype, figures 51–54, 189 and 190

*Micriphantes infulata* Koch and Berendt, 1854, p. 40, fig. 29.

The specimen is a mature male, but its palpi and legs are so flexed that some of the important characters cannot be seen. Moreover, it was mishandled before it was placed in my hands for study and the amber itself is far from being free of imperfections. Nevertheless, as the accompanying photographs and figures show, there can be no doubt of its proper generic affiliation.

Total length in the position in which it appears when examined from above 1.7 mm. The abdomen is in good shape but twisted at a considerable angle out of its normal position. It is much larger than the carapace, ellipsoidal. Its greatest length is 1.25 mm. Its width 0.95 mm. and the length of the short, vertical axis of the ellipsoid, which may be regarded as the height of the abdomen 0.90 mm. The carapace (figure 53) is also preserved without any distortion to speak of. Its length from the vertex of the anterior median eyes to the posterior edge is 0.75 mm. The maximum width is 0.65 mm. and the

maximum height in the region of the posterior median eyes 0.50 mm. The height of the thoracic portion in the short region preceding its almost vertical declivity is 0.35 mm., i.e. the head is distinctly elevated above the thorax. Along the sides of the head the thoracic portion runs for a while level, only to dip suddenly anteriorly at a very steep angle as shown in figure 51. The eye group projects distinctly beyond the clypeus, the entire configuration of the carapace giving it a very peculiar appearance. The eye group itself is very difficult to study, but with patience and proper lighting all eyes can be seen and measured. They are shown in figure 54. The diameter of the anterior median eyes is 0.12 mm., that of the posterior median eyes 0.05 mm., and the lateral eyes appear to be only slightly, if at all larger than the posterior median ones. The quadrangle is 0.25 mm. wide in front, 0.16 mm. wide behind and 0.16 mm. long, i.e. it is much wider in front than behind and much wider than long. The lateral eyes are contiguous. The width of the eye group is 0.44 mm.

| Legs | Femur | Pat.+Tibia | Metatarsus | Tarsus | Total |
|---|---|---|---|---|---|
| I | 0.75 | 0.77 | 0.45 | 0.30 | 2.27 |
| II | 0.62 | 0.45 | 0.30 | 0.25 | 1.62 |
| III | 0.47 | 0.40 | 0.25 | 0.22 | 1.34 |
| IV | 0.75 | 0.75 | 0.45 | 0.30 | 2.25 |

| Leg formula | 1 | 4 | 2 | 3 |
|---|---|---|---|---|
| | 3.0 | 3.0 | 2.1 | 1.8 |

There are no true spines on the legs, but on the tibia of all legs are 1–1 dorsal, stiff, straight and fine bristles. The first of them is about one fifth from the base, the second about three quarters from the base of the joint. The structure of the claws cannot be seen, nor is it possible to see the fourth tarsi in a position which would show the comb. Of interest is the crest on the first metatarsus (figure 52) consisting of long and stout hairs or bristles forming a mid dorsal row and continuing in the same way to the end of the tarsus while decreasing at the same time in length. On the midventral line of the first tarsus there is also a row of stout, but short hairs. The rest of these joints, like the other joints of all legs is clothed with short, simple hair.

The sternum can be seen best in profile and appears then to be very convex. The first coxae are far apart, the fourth coxae close together. Both palpi are in plain view, but so flexed that their structure cannot be seen. The spinnerets are also visible, but not well enough for a drawing.

## Subfamily THERIDIINAE

### Genus FLEGIA Koch and Berendt 1854

Type *F. longimana* K. and B.

#### FLEGIA LONGIMANA K. and B.

Figure 55

This species, first described by Koch and Berendt and then by myself in 1946, can be separated from *F. succini* Petrunkevitch (1942) by the following characters:

a) Order of legs 1243. Sternum slightly convex, little longer than wide, bluntly pointed behind. Carapace somewhat longer than wide (1.5 by 1.2). *F. succini*

b) Order of legs 1423. Sternum very convex, distinctly longer than wide, prolonged and slightly bifid at posterior end. Carapace as wide as long. *F. longimana*

The Museum of Comparative Zoölogy has two specimens, belonging to the species *F. longimana*. Specimen 7183 is a damaged one, but the carapace shows the eye tubercle plainly, and both palpi are visible. It is a mature male. Specimen 7225 has several of its legs damaged by careless polishing on the part of a previous owner, but the carapace, both palpi and the abdomen are complete. It lies in almost perfectly clear amber. Since it was impossible to give a good figure of the sideview of the specimen belonging to the American Museum, and since this specimen shows it particularly well I have drawn it, omitting all other features and representing only the carapace and the left palp. The specimen was purposely tipped slightly out of absolute profile, to show more clearly the dip between the left and right cheeks of the thorax (figure 55). The relative length of the palpal femur is also best appreciated in this position.

## 36 Family LINYPHIIDAE

### Genus LINYPHIA Latreille 1804

Type *L. triangularis* (Clerck)

#### LINYPHIA OBLONGA Koch and Berendt 1854

Figures 50 and 188

Koch and Berendt mention two mature males, and state that except for the palpi which are those of mature individuals but are thickly covered with emulsion (Schimmel), the rest of the structures are clearly visible. I refer to this species specimen No. 8519 (figure 188) which is a mature male, because of its general resemblance to Koch's figure although I doubt very much that it really belongs to the Genus Linyphia. Unfortunately the specimen is poorly preserved and the structure of the palpi cannot be seen, so that the only statement that one can make concerning them is that they are undoubtedly of a sexually mature individual, that their femur is comparatively short and straight, their patella and tibia small and of about equal size and the cymbium distinctly larger, but not conspicuous. The specimen has a total length of 2.57 mm. and its abdomen is 1.75 mm. long and 1.25 mm. wide. But the length of the carapace cannot be measured because the cephalothorax is bent upward, out of its normal position. Nor can its width be measured. The head is elevated above the thorax and the legs which are all complete, are flexed as one can see in the photograph. They are clothed with hair and there seem to be only two fine spines present on each leg, both dorsal in position and one of them at the end of the patella, the other on the tibia about three quarters from its base. There certainly is no tarsal comb present on the fourth tarsi, nor any calamistrum on the fourth metatarsi, so that the familial affiliation is certain. The abdomen resembles that of Recent Linyphias. Of the spinnerets only the anterior pair is visible. The legs can be measured exactly, but since the length of the carapace cannot be measured, only the order of the legs, 1243, can be given. The legs have a slender appearance.

| Legs | Femur | Pat.+Tibia | Metatarsus | Tarsus | Total |
|---|---|---|---|---|---|
| I | 3.14 | 3.14 | 3.29 | 1.43 | 11.00 |
| II | 2.30 | 2.30 | 2.40 | 1.10 | 8.10 |
| III | 1.15 | 1.15 | 1.00 | 0.85 | 4.15 |
| IV | 2.05 | 1.90 | 2.00 | 0.85 | 6.80 |

The eyes are shown in figure 50. The eye group is considerably narrower than the head. The pair of anterior median eyes are elevated

on a transversely ellipsoidal tubercle. The lateral eyes are also elevated on a common tubercle on each side, but the posterior median eyes are sessile. The quadrangle is very slightly narrower in front than behind and as long as wide. The clypeus is as high as one half the length of the quadrangle. Viewed from in front as shown in the figure the anterior row of eyes is recurved, the posterior row procurved and the clypeus is steeply inclined forward, so that the anterior median eyes look almost straight ahead.

## 37 Family ARGIOPIDAE

### Subfamily ARANEINAE (= EPEIRINAE)

### Genus EUSTALOIDES Petrunkevitch 1942

Type *E. setosus* Petrunkevitch

The specific and in some cases even the generic characters of Recent spiders are not always applicable to both sexes, at least in the present state of our knowledge. It is not uncommon that generic characters are based on peculiarities in the structure of the female epigynum or the male palp, or even on secondary sexual characters such as the shape of the head. Specific characters are almost entirely in this category. When it will be remembered that in several cases of Recent spiders males and females were assigned to the same species, only to discover later that they belong to different species, it will be realized how difficult it is to place a fossil spider in any species of the opposite sex. In the case of Eustaloides the generic characters apply to both sexes, but the specific characters applicable to the males are insufficient for the distinction of females of which we have a single species and that represented by only two specimens. The three species represented by males can be distinguished by the structure of their palpi. However, in fossil spiders it is not nearly as simple to compare the palp of one specimen with the palp of another, because one cannot handle the specimen in the manner in which one handles Recent ones and has to depend entirely upon structures which can be seen. Even then it is not always simple to understand the picture of such a complicated organ as the palp when it happens to be viewed at an angle different from that at which it was figured for the type. For this reason I am giving here new figures for each of the two species previously described by me and corresponding figures for the new species for the purpose of making comparisons between them simpler and easier to under-

stand. The terminology of palpal structures, used here, is that proposed by Comstock in 1910. While far from satisfactory for lack of comprehensive embryological evidence, it still is helpful in making comparison of certain structures possible even though their function remains unknown.

The three species may be distinguished on the basis of these structures as follows:

1. Terminal apophysis curved and large. Paracymbium without a heel, i.e. not boot-shaped ..... 2
– Terminal apophysis bilobed. Paracymbium boot-shaped, with a distinct, high heel ..... *E. calceatus*, n. sp.
2. Median apophysis large, pointed, protruding at right angles to the longitudinal axis of the palp. Subterminal apophyses seemingly wanting .... *E. succini*
– Median apophysis wanting. Median subterminal and lateral subterminal apophyses well developed ..... *E. setosus*

## Eustaloides setosus Petrunkevitch

### Figures 80–82, and 194

*Eustaloides setosus* Petrunkevitch, 1942, p. 318, figs. 279–288, and 590; *idem*, 1946, figs. 42–43.

Specimen No. 7445, figure 80–82, which belongs to this species is a mature male. Its left side is completely entangled in some threads of vegetation, which are besides held together by a heavy coating of white emulsion. The best view of the specimen is presented by its right side, but even so the abdomen can hardly be seen through a layer of imperfect amber. The total length of the specimen is about 3.5 mm. The carapace is 1.9 mm. long, but its width cannot be measured because of the shape of the piece given it presumably by some jeweller. The legs can be measured very exactly without much trouble and these measurements prove that this specimen has relatively somewhat longer and thinner legs than the type. The difference is greater than what one would expect in a case of normal variation, but the difference may be accounted for by the distortion of the carapace.

| Legs | Femur | Pat.+Tibia | Metatarsus | Tarsus | Total |
|---|---|---|---|---|---|
| I | 2.25 | 2.80 | 2.45 | 0.85 | 8.35 |
| II | 1.95 | 2.15 | 1.85 | 0.70 | 6.65 |
| III | 1.50 | 1.30 | 1.10 | 0.45 | 4.35 |
| IV | 1.70 | 1.70 | 1.25 | 0.50 | 5.15 |

| Leg formula | 1 | 2 | 4 | 3 |
|---|---|---|---|---|
| | 4.4 | 3.5 | 2.7 | 2.3 |

The palpi are shown in figures 80–82. The paracymbium is difficult to see on account of its position and black color, difficult to differentiate from the black color of the apophyses serving as background. The terminal apophysis is shown in two views and it will be at once noticed by comparison of figure 81 with figure 282 of the type, published by me in 1942, that it has the same structure. The median and lateral subterminal apophyses shown in figure 80 may be seen only in the left palp, but are here plainly visible.

I refer to this species also specimen 8213 which is an immature male in the penultimate instar. If a greater number of mature and immature specimens were available the identification could be better verified. At present the general appearance rather than anything else has decided me in favor of this assumption. The total length of the specimen is ca. 3.9 mm. The carapace is 1.90 mm. long, 1.40 mm. wide, i.e. rather unusually narrow. However, it is distinctly distorted, the left side being narrower than the right side. If a corresponding correction of measurement is made the width is to be placed at 1.50 mm. The width of the carapace of specimen 7445 cannot be measured, but for the carapace of the type I gave the figures of 2.2 by 1.8 mm. This shows fairly good agreement.

| Legs | Femur | Pat.+Tibia | Metatarsus | Tarsus | Total |
|---|---|---|---|---|---|
| I | 2.10 | 2.50 | 3.00 | 0.75 | 7.35 |
| II | 1.75 | 1.85 | 1.35 | 0.65 | 5.60 |
| III | 1.20 | 1.10 | 0.85 | 0.40 | 3.55 |
| IV | 1.60 | 1.35 | 1.25 | 0.50 | 4.70 |

| Leg formula | 1 | 2 | 4 | 3 |
|---|---|---|---|---|
| | 3.8 | 3.5 | 2.5 | 1.8 |

The specimen is well preserved in clear amber. Only the first left leg is missing and there is white emulsion on the ventral surface around the mouthparts.

Specimen No. 7953, a male also belonging to this species, is shown photographically in figure 194.

### Eustaloides succini Petrunkevitch 1942

Figures 56–65, and 191

This species is represented in the collection of the Museum of Comparative Zoölogy by two specimens, both mature males, one of them so perfectly preserved that it adds considerably to our knowledge of the species as described in 1942 on the basis of a single specimen.

For this reason a detailed description with several figures and a photograph of the specimen (No. 8219) are given here.

Total length 3.85 mm. The appearance and general proportions of the specimen are best understood from an examination of the photograph (figure 191) and of the drawings showing the dorsal view of the body corrected for symmetry and the first and third legs drawn to the same scale with the body (figures 63–65). The carapace is 1.60 mm. long, 1.45 mm. wide between second and third coxae, strongly narrowed in front, with the anterior median eyes projecting beyond the anterior edge. The surface of the carapace is glabrous, devoid of pubescence except for a very few hairs in the region of the eye group. The color is dark red-brown, coppery. The thoracic groove is longitudinal, and the cephalothoracic sulci are fairly visible. The eye group composed of eight eyes is 0.60 mm. wide (figure 59). The ratio of the eyes is AME : ALE : PME : PLE = 9 : 6 : 6 : 6. The eyes of the posterior row are about equidistant, separated from each other by their diameter. The lateral eyes are contiguous, placed on a joint tubercle on each side of the head. This tubercle is separated by a deep cleft from the tubercle bearing the anterior median eyes. The posterior median eyes alone are on a level with the surface of the head. The quadrangle of median eyes is 0.32 mm. wide in front, 0.30 mm. wide behind, 0.37 mm. long. The clypeus is lower than the diameter of the anterior median eyes.

The chelicerae are more or less cone-shaped, short and rather slender. No boss can be seen and the view of the margins and of the fangs is obstructed by the palpi.

The specimen seems to have been once used as a pendant and a channel drilled as far as the surface of the sternum was filled with some yellow resin and sealed with a white substance obstructing the view. When the channel was cleaned and the specimen washed in xylene not only this extraneous substance disappeared, but a great deal of the white emulsion covering the abdomen and the coxae became also cleared. The sternum itself was ruined by the drill, but the maxillae, the lip and the coxae are now plainly visible. The anterior end of the coxo-sternal region is shown in figure 58. The lip is wider than long and has a rounded, thickened anterior edge. The first pair of coxae is separated by about three times the width of the lip. The fourth coxae are narrowly but clearly separated by at least a quarter of their width. None of the coxae has either an apical hook or a basal spur of any kind.

The legs have a spinose appearance, the spines being rather long and stout (figures 63 and 64). There is a slight dissimilarity in the structure of the claws of the first pair of legs. The proclaw (figure 60)

has only six teeth, while the retroclaw has nine (figure 61). The third claw is almost as long as the upper claws and has a single tooth about one third from its base, where it is strongly bent. The upper claws of the following three pairs of legs have from four to five teeth and the third claw is smooth (figure 62). Spurious claws are present, but their number cannot be determined on account of the position of the legs. Neither can any trichobothria be seen. The legs are clothed with simple hair directed at an angle forward, but on the first and second tarsi and on the distal fifth of the metatarsi of those legs short, erect hairs stand at regular intervals between the other hairs.

| Legs | Femur | Pat.+Tibia | Metatarsus | Tarsus | Total |
|---|---|---|---|---|---|
| I | 2.25 | 2.60 | 2.00 | 0.75 | 7.60 |
| II | 1.75 | 2.00 | 1.50 | 0.60 | 5.85 |
| III | 1.20 | 1.30 | 0.80 | 0.45 | 3.75 |
| IV | 1.20 | 1.60 | 1.20 | 0.55 | 4.55 |

| Leg formula | 1 | 2 | 4 | 3 |
|---|---|---|---|---|
| | 4.7 | 3.6 | 2.8 | 2.3 |

Length of femur of palp 0.40 mm.

Width of first patella 0.26 mm. First tibial index 10.

Width of fourth patella 0.21 mm. Fourth tibial index 13.

The first femur has a distinctly sigmoid shape (figure 63). *Spines.* First leg, femur dorsal 0–1–1, prolateral 0–1–1, retrolateral 0–0–1; patella dorsal 1–1 (the first a bristle, the second an apical spine), retrolateral 1 at the protruding angle; tibia dorsal 1–1–1, prolateral 1–1–1, retrolateral 0–1–1, ventral 0–2–2; metatarsus dorsal 1–1, retrolateral 1–1. No other spines on first leg. Second leg same as first. Third leg, femur dorsal 1–0–1, prolateral 0–0–1, retrolateral 0–0–1; patella dorsal 1–1 (the first a bristle), retrolateral 1; tibia dorsal 1–1–1, prolateral 0–1–1, retrolateral 0–1–1, ventral 1p–1p–2; metatarsus prolateral 1–1, retrolateral 1–1. No other spines on third leg. Fourth leg same as third except femur dorsal 1–1–1.

There are no spines on the palp, but a fine bristle near the end of the femur, two stout and long bristles on the patella and several fine bristles on the tibia. The two bristles on the patella appear at a first glance to be a pair, but when one considers their position in relation to the articulation points between the femur and the patella they must be certainly homologized with the dorsal 1–1 spines on the patella of the legs. The tibia of the palp has a distinct lateral angular projection (figures 56 and 57). The paracymbium is plainly visible, black, more or less scoop-shaped, without a heel. The median apophysis projects at right angles to the longitudinal axis of the palp, is suddenly attenuated and pointed at the end. The terminal apophysis seems to serve as a protecting shield for the curved embolus.

The abdomen is ellipsoidal, evenly rounded at both ends, 2.25 mm. long, 1.70 mm. wide. It is light colored and has a somewhat silvery appearance. On its back four pairs of light brown dorsal muscular attachment discs are visible (figure 65). The fourth pair is quite small and easily overlooked. The back is clothed with stout bristles of various length. The anterior end of the abdomen overlaps the posterior edge of the carapace. On the ventral surface the spinning group is well visible, typical of the family and the little colulus is visible through the bubble situated in contact with the anterior spinnerets. The ventral abdominal wall has no bristles, but only short, simple hair.

Specimen 8022 is also a mature male. Several of its legs had been cut off, but in other respects it is a well preserved specimen and its palpi show the characteristic structure. The total length of the specimen is 3.9 mm. The carapace is 1.90 mm. long, 1.45 mm. wide, narrowed in front.

| Legs | Femur | Pat.+Tibia | Metatarsus | Tarsus | Total |
|---|---|---|---|---|---|
| II | 1.85 | 1.75 | 1.70 | 0.65 | 5.95 |
| III | 1.40 | 1.10 | 1.10 | 0.50 | 4.10 |
| IV | 1.75 | 1.85 | 1.50 | 0.50 | 5.60 |

The abdomen is 2.15 mm. long, silvery grey, with four pairs of dorsal muscular attachment discs. The surface is distinctly rippled.

### Eustaloides calceatus spec. nov.

Figures 75–79 and 192

This new species is represented by two specimens, both mature males and both badly mishandled. Fortunately the palpi are well preserved and especially in the type are so situated that the shape of the paracymbium is apparent at a first glance.

Type, specimen 7444. Figure 192. All legs cut off, only the femur and patella of the first pair and the femur of the left second leg remaining. Total length of the specimen 4.4 mm. Carapace 2.0 mm. long and 2.0 mm. wide, almost circular in appearance were it not for the fact that its sides become concave just behind the lateral eyes, where its width is 1.0 mm. The eye group (figure 76) is 0.77 mm. wide. The ratio of the eyes is AME : ALE : PME : PLE = 10 : 7 : 4.5 : 7. This means that the posterior median eyes are relatively appreciably smaller than in the other two species. The quadrangle is appreciably shorter than wide in front, the actual measurements being 0.43 mm. anterior width, 0.39 mm. posterior width, while the length is 0.37 mm.

The cleft between the anterior median and the lateral eye-tubercle is not as deep as in *E. succini*. The lip is of the same type. The sternum (figure 75) is considerably longer than wide and acutely pointed behind the fourth coxae which are separated by about half their width. The first coxae are separated by somewhat more than twice the width of the lip. None of the coxae has any apical hook or basal spur. The first femur is 2.6 mm. long, the second ca. 2.2 mm. The abdomen is 2.7 mm. long, 2.0 mm. wide. It is rounded in front, but posteriorly forms an angle and is distinctly flattened above. Both palpi are fully exposed to view. The terminal apophysis is bilobed (figure 77), the paracymbium has a high heel, giving it the appearance of a boot.

Specimen 6368 is also a mature male and almost as badly mishandled as the type. The posterior end of the abdomen is polished off as well as its ventral surface, and all legs with the exception of the right first and second lack their last two joints. Moreover the carapace is distorted, its posterior declivity apparently bent forward in the process of fossilization, so that the carapace appears to be wider than long. Its maximum width is 1.9 mm., whereas the length is only 1.5 mm. representing almost nothing but the length of the head from the anterior end to the thoracic groove.

| Legs | Femur | Pat.+Tibia | Metatarsus | Tarsus | Total |
|---|---|---|---|---|---|
| I | 1.90 | 2.25 | 1.35 | 0.60 | 6.10 |
| II | 1.70 | 2.15 | 1.25 | 0.55 | 5.85 |
| III | 1.50 | 1.50 | 1.10 | 0.50 | 4.60 |
| IV | 1.70 | — | — | — | ? |

The palpi are so placed that although the paracymbium is plainly visible its heel can be recognized only when the specimen is rotated in oil. Since the appearance of a palp varies depending upon the angle of view, the same right palp is shown in two different positions in figures 78 and 79. The median apophysis is very different from that of *E. succini* and moreover is much smaller and therefore less conspicuous.

### Eustaloides minor spec. nov.

Figures 66–74 and 193

A well preserved specimen, but badly mishandled and in such dark amber that it can be studied only in monochromatic, strong light. The back of the abdomen was polished off and filled with a white substance which had to be removed before sufficient light could be

admitted to some structures for their study, while the specimen was immersed in mineral oil, as well as for the purpose of photography.

*Type.* Mature female, 7137. Figure 193. Total length 3.8 mm. Carapace 1.9 mm. long, 1.4 mm. wide between second and third coxae, 0.75 mm. wide in face view. Viewed from above it has the shape shown in figure 67. Its lateral view shown in figure 72 is the result of study, not a drawing made with the aid of a camera lucida as the others are, because there is not a single position in which the complete carapace could be viewed from its side. Nevertheless I believe the reconstruction to be more or less correct. The median crest of hair can be seen only with difficulty. The head is clearly outlined by the sulci which converge at the anterior end of the short, longitudinal thoracic groove. The eyes protrude beyond the anterior edge of the carapace. The eye group (figure 71) is slightly narrower than the head. The anterior median eyes are the largest, in contact with each other and but slightly removed from the lateral eyes. The four median eyes are on a tubercle (figure 70) and the two lateral eyes of each side are also on a tubercle. The clypeus is lower than the diameter of the anterior median eyes. Measurements are very difficult and not reliable on account of the darkness of the amber.

The chelicerae are slightly geniculated, stout, without boss. Their margins are not visible. The coxo-sternal region is shown in figure 74. The sternum is flat, 0.85 mm. long, 0.65 mm. wide, truncated and distinctly emarginate in front, bluntly pointed behind. Its surface is sparsely clothed with coarse hair. The first coxae are wide apart and distinctly larger than the others. The fourth coxae are subcontiguous.

| Legs | Femur | Pat.+Tibia | Metatarsus | Tarsus | Total |
|---|---|---|---|---|---|
| I | 1.75 | 2.20 | 1.65 | 0.65 | 6.25 |
| II | 1.40 | 1.60 | 1.00 | 0.50 | 4.50 |
| III | 1.20 | 1.10 | 0.70 | 0.45 | 3.45 |
| IV | 1.25 | 1.25 | 0.75 | 0.50 | 3.75 |

| Leg formula | 1 | 2 | 4 | 3 |
|---|---|---|---|---|
| | 3.3 | 2.4 | 2.0 | 1.8 |

*Spines.* First leg, femur dorsal 0–1–1, prolateral 0–1–1; patella dorsal 1, prolateral 1; tibia dorsal 1–0–1 (the first a bristle), prolateral 1–1–1, retrolateral 0–1–1, ventral 0–2–2; metatarsus prolateral 1–1, retrolateral 1–1. No other spines on first leg. Second leg, femur dorsal 0–1–1, prolateral 0–0–1, retrolateral 0–0–1; patella dorsal 1, retrolateral 1; tibia dorsal 1–0–1, prolateral 1–1–1, retrolateral 0–1–1, ventral 0–2–2; metatarsus prolateral 1–1, retrolateral 1–1 as in first leg, but the spines are distinctly stouter. No other spines. The spines

on the third and fourth leg cannot be studied on account of the position of the legs. Neither the trichobothria, nor the claws can be studied. A palpal claw is present and is shown in figure 66. The pedal claws are apparently more or less of the same type.

The abdomen is ellipsoidal, evenly rounded at both ends, 2.5 mm. long, 1.9 mm. wide. Its anterior end overlaps the posterior edge of the carapace. The back of the abdomen, as already mentioned, had been polished off, but the hair in front and behind the opening is sparse and coarse and sticks out through the white emulsion which partly covers the body wall. The spinning group is of the usual type (figure 73). There is a well developed colulus present and in front of it the tracheal spiracle appears as a little crescent. The epigynum shown from below and in profile, is quite prominent and characteristic. It seems to be complete. At least when one examines the specimen in oil one can look at the inner surface of the epigynum through the artificial opening on the back of the abdomen.

It is always difficult to decide in spiders whether a single specimen belongs to the same species as specimens of the opposite sex. In most species of the family Argiopidae the females are larger than the males in now living representatives. *Eustaloides minor* is smaller than the males which I have described as *E. setosus*, *E. calceatus* and *E. succini* from Baltic amber. This is the reason why I thought it advisable to place the female into a new species. There are of course other differences of structure, which may be sexual, but may be specific as well.

Another specimen, 7191, which I designate as paratype, is ca. 4.6 mm. long, the greater size being due to a considerable distention of the abdomen. It is also a mature female, not nearly as well preserved as the type, but with the epigynum well visible. The amber is light colored, but full of imperfections making the study difficult.

## Subfamily METINAE

### Genus ACROMETA Petrunkevitch 1942

Type *Acrometa cristata* Petrunkevitch

#### ACROMETA CRISTATA Petrunkevitch

Five mature males of this characteristic species, conforming in almost every detail with my description and figures of 1942. Only specimen 7189, which is poorly preserved, looks at first glance somewhat different, inasmuch as its head appears to be much broader.

I think this is due to distortion in fossilization since the palpi, the crest on the carapace and the shape and investment of the bristles are typical.

## Subfamily THERIDIOSOMATINAE

### Genus ELUCUS Petrunkevitch 1942

Type *E. inermis* Petrunkevitch

In studying amber spiders one meets with species which combine characters of several Recent families. Any deviation due to distortion or to loss after death and fossilization can be easily recognized and discounted. Thus hair, bristles and even spines may be lost even in Recent spiders, while the structure of claws and the number and arrangement of trichobothria are often difficult to determine. When, however, every structural detail is present and can be studied, then such intergrading of characters may mean only one of two things. Either the existing classification is wrong, being applicable only to extreme forms of what should be regarded as a single family, or else, in the case of fossil species, we are in the presence of an efflorescence of characters before the process of natural selection eliminated species with intergrading characters. A case in question is presented by the Genus Elucus, which I proposed for a species of spider from the Baltic amber and placed in the Subfamily Theridiosomatinae. That subfamily includes only eight genera of Recent spiders, all small in size, with rather short legs, resembling some Erigonidae in appearance. *Elucus inermis* resembles more a spider of the Family Linyphiidae or some Theridiid by its general appearance, yet is distinct from both. It has the legs, the maxillae and the lip of a Linyphiid, but its male palp lacks a paracymbium so characteristic of that family. It cannot be placed in the Theridiidae, because it lacks a tarsal comb, or at least the ventral row of bristles on the fourth tarsi does not differ appreciably from the dorsal row or the lateral rows. Only if these rows were lost or were replaced by considerably smaller hairs could the ventral row be likened to a comb. The color of the eyes does not come under consideration in amber spiders, because all eyes become transparent, so that a distinction between so called diurnal and nocturnal eyes is impossible unless the shape is peculiar. But in Elucus the eyes are round. In the first half of the 19th century, i.e. at the time when Koch and Menge published their important works, Linyphiidae and Theridiidae and even Mimetidae were still considered to belong to a single family. The discovery of the second species of Elucus only

confirms the impossibility of assigning this genus either to the Theridiidae or to the Linyphiidae. For this reason I still place it in the Subfamily Theridiosomatinae although it does not conform unconditionally with that group either.

### Elucus infelix spec. nov.

Figures 83–89, 200 and 201

*Type*, 7002. Figure 200. Mature male. Total length 2.2 mm. Carapace 1.0 mm. long, 0.90 mm. wide, 0.35 mm. high. Abdomen 1.25 mm. long, 0.90 mm. high, 1.00 mm. wide. The appearance of the spider is best understood from the photograph taken in side view because of the shape of the piece which makes the study of the dorsal surface difficult and photography impossible. The side view is also shown on a larger scale in the drawing (figure 86) in which three femora of the left side are shown, to emphasize their respective lengths, while the first femur is omitted for lack of space and because it obstructs the view of the eyes. The dorsal view of the carapace is shown in figure 84. It differs from that of *E. inermis* in which species the width of the head is greater than that of the eye group. In *E. infelix* the eye group is 0.47 mm. wide and the eyes project beyond the edge of the head on each side. The ratio of the eyes is: AME : ALE : PME : PLE = 9 : 5 : 8 : 5, i.e. the lateral eyes which are contiguous and are placed on each side of the head on a joint tubercle are the smallest, while the posterior median eyes are only a little smaller than the anterior median eyes. The eye group cannot be studied under high power, nor can the length of the quadrangle be measured. Its width in front is about the same as behind, and the clypeus appears to be about as high as the diameter of the anterior median eyes. The sternum is distinctly convex. Its shape cannot be studied, but it is certain that the first coxae are wide apart and the fourth coxae are separated by a little more than their width. Of the mouthparts only the chelicerae can be seen (figure 85). In a certain position and light three teeth may be faintly seen, but it is not possible to determine on which margin they are. The legs are long and thin, practically without spines except for very fine dorsal ones of which there are 1–1 on all patellae and 1–1 on all tibiae. The claws are slightly dissimilar although their outline along their dorsal line is more or less the same. But the proclaw is smooth, while the retroclaw has three teeth on the first and second leg (figures 87–89) and only one tooth on the third leg. The claws of the fourth pair of legs cannot be seen in profile. The third claw is smooth on all legs. There seem to be two pairs of serrated bristles at the end of the tarsi.

| Legs | Femur | Pat.+Tibia | Metatarsus | Tarsus | Total |
|---|---|---|---|---|---|
| I | 2.40 | 2.40 | 2.50 | 1.05 | 8.35 |
| II | 1.85 | 1.85 | 1.85 | 0.85 | 6.40 |
| III | 1.05 | 0.90 | 0.85 | 0.45 | 3.25 |
| IV | 1.65 | 1.55 | 1.55 | 0.70 | 5.45 |

| Leg formula | 1 | 2 | 4 | 3 |
|---|---|---|---|---|
| | 8.3 | 6.4 | 5.4 | 3.2 |

Compared with the measurements of the legs in *Elucus inermis* the new species has relatively slightly longer legs. An interesting difference is in the measurements of the third leg, for in *Elucus inermis* the patella with the tibia are almost by a quarter longer than the femur, and the metatarsus by two fifths longer than the femur; in *E. infelix* the femur is the longest, the metatarsus the shortest and the difference between the two amounts to no more than 10%.

Both palpi are remarkably well preserved and their internal structure is clearly visible although it requires careful study, and the free end of the embolus is quite colorless, so that it easily escapes observation. Figure 83 is drawn at a large scale and shows that on leaving the sperm receptacle the duct forming the embolus makes nearly one and one-half turns of a spiral. At the end of the bulb the pointed conductor appears more or less in the same place as in the type (1942, figure 115) which I mistook then for the embolus (page 341). The latter is presumably not visible in the position in which the palp appears on the figure. There is however a well visible difference in the structure of the tibia which has a very distinctly protruding angular apophysis in *E. infelix* (figure 83.) It has also two trichobothria, one behind the other. The cymbium is covered with thin hair with exception of its end on which several very thick hairs may be seen.

To this species I refer another specimen, a mature male No. 7127 *a*, shown in figure 201. The specimen is not nearly as well preserved as the type, the legs are all flexed and the dorsal surface of the carapace and abdomen is missing, having been cut off by the previous owner for mounting on a slide. The identification is therefore not beyond possible doubt. The legs look somewhat stouter, but have the same type of hair and the claws visible on one of the legs resemble those of the type. The structure of the palpi cannot be seen because of their position, but one can discern at the end a structure which looks like a short thorn.

### Elucus inermis Petrunkevitch 1942

Figure 199

The type of this species is in the British Museum and is a mature male. I refer to this species with reservation a defective female, No.

7707 *a* of the Mus. of Comp. Zcöl. shown in figure 199 photographically. The abdomen is missing and the spider can be seen only in front view.

## Family EPHALMATORIDAE, new

There are three genera of spiders found in the Baltic amber, which are characterised by the possession of enormous ventral spines on the tibia and metatarsus of the first and second pair of legs. Two of these genera, Eostasina and Esuritor, I have described in 1942. The third, new genus Ephalmator is described here for the first time. The three genera belong to three different families and their possession of unusually long spines on the same legs and in the same places is a striking example of parallelism in evolution. The separation of the three genera is quite simple and beyond all possibility of a mistake unless, indeed, the required characters are missing through loss of appendages and either loss or obstruction of the view of the spinnerets and eye group. The genera may be separated as follows:

1. Two claws. Legs laterigrade, long, in order 4123, but with little difference in length. First and second tarsus and metatarsus finely scopulate. First and second tibia with four pairs of long, ventral spines, first and second metatarsus with three pairs of similar spines..... Genus *Eostasina* (Eusparassidae)

– Three claws.....2

2. Order of legs 4132. Trichobothria numerous. In addition to the long ventral spines on the metatarsus and tibia of the first and second pair of legs, there are many spines of normal length on all legs. Eye group almost as wide as head. Spinnerets cylindrical, posterior pair slightly longer than anterior pair. Colulus present. Genus *Esuritor* (Pisauridae)

– Order of legs 1423. A single trichobothrium on tarsus. Legs without other spines than the long ventral ones on first and second tibia and metatarsus. Only the fourth tibia has a subapical pair of very small ventral spines. Head considerably wider than the eye group. Spinnerets cone-shaped, anterior pair much stouter than posterior pair. Colulus wanting..... Genus *Ephalmator*, new (Ephalmatoridae)

The creation of a new family is always a matter for serious consideration. In the present case, as may be seen from a comparison of the characters of the new family given below with the characters of the other two families the Ephalmatoridae may be easily separated from the latter. But this is not the case when one considers other families of the Branch Trionychae of the Suborder Dipneumonomorphae. The Ephalmatoridae have some characters in common with several other families, namely Argiopidae, Erigonidae, Theridiidae,

Agalenidae and even Zodariidae. Yet they also differ from each of these either by the lack of important characters or by the possession of characters lacking in the others. Thus the lack of a comb on the fourth tarsi and the possession of powerful ventral spines makes their inclusion in the Theridiidae impossible. Complete absence of serrated bristles and of spurious claws as well as of a colulus separates them from the Argiopidae; the shape of the spinnerets and the lack of plumose hair and of the characteristic row of tarsal trichobothria alienates them from the Agalenidae; the Erigonidae have spurious claws and their palp in males has a tibial apophysis, characters lacking in Ephalmatoridae. The shape of the spinnerets and the disposition of the eyes as well as the peculiar spines separate them from the Zodariidae. If it were not for the high degree of specialization immediately apparent when one studies the external features of the Ephalmatoridae, one would be inclined to consider them as ancestral forms of the above mentioned families. This is quite unlikely. All the enumerated families are already represented in the Baltic amber and (with the exception of the Zodariidae) were more common, if judged by the number of known species. Moreover, they all exhibit already the characteristic features of the Recent representatives. One is forced to the conclusion that the Ephalmatoridae represent a branch which became early specialised and for some reason was unable to survive.

*Characters of the family.* Dipneumonomorph spiders of the Branch Trionychae. Three claws. Serrated bristles, spurious claws and claw tufts wanting. Fourth tarsus without a comb. A single trichobothrium on tarsi. Chelicerae with a boss and transverse margins. Lip free, flat, not thickened at end. Maxillae parallel. Legs prograde. Trochanters not notched. First coxae wide apart. Six spinnerets. Anterior pair close together, cone-shaped and much stouter, but equally long with the posterior pair. Both pairs capable of producing silk with viscous droplets. Colulus wanting. Hair simple. Male palp without paracymbium and without tibial apophysis.

## Genus EPHALMATOR, new

In addition to its familial characters the genus presents the following distinguishing features: Eye group narrower than head. First and second tibia with 2–2–2–1p ventral spines of unusual length. Promargin of chelicerae with a scopula of long bristles arranged in a single row; retromargin smooth. Sternum fairly convex. Legs short and stout. Type *E. fossilis.*

### Ephalmator fossilis spec. nov.

Figures 90–108, 195 and 196

Type: figure 90–98, 102, 103, 105–108; 196. Paratype: figures 99, 100, 104, 175 and 195.

*Type.* Mature male, No. 7882. Figure 196. Originally in light colored amber with numerous planes of cleavage. On polishing the surface of the piece and soaking it in mineral oil, the amber became quite clear. The only imperfections are the presence of an air-bubble which pressed in and obstructed the view of the left side of the abdominal ventral surface, and the damage to two legs: the right second leg lacks the metatarsus and tarsus, the right third leg is missing beyond the femur.

Total length 2.65 mm. Carapace 1.30 mm. long, 1.00 mm. wide between second and third coxae, 0.50 mm. wide in the region of the eye group, the latter being only 0.50 mm. wide. Viewed from above (figure 90) the carapace reveals a rather long head clearly outlined by the cephalothoracic sulci. There are practically no hairs on the carapace, except for the very few on the head. Viewed from the side the carapace (figure 94) shows that its highest point is at the posterior end of the head. From here on it slopes forward in a gentle curve, while its posterior declivity is straight and much more inclined. The thoracic groove is longitudinal and is situated on the posterior declivity. The eight eyes are arranged in two rows, both slightly procurved (figure 93). The anterior median eyes are the smallest and are closer to each other than to the ALE. The four eyes of the posterior row are equal in size and separated by less than their diameter. The lateral eyes on each side are elevated on an elongated, low tubercle. The clypeus is equal to three diameters of the AME and is, therefore, not as high as the length of the quadrangle of medians. The latter is much narrower in front than behind and considerably wider than long. The second row of eyes is wider than the first row. All eyes are round.

The chelicerae are stout and rather short. The boss (figure 102) may be plainly seen in some positions, but is not prominent. The margins are transverse. The promargin has a scopula composed of fairly long and stout bristles. The retromargin is smooth. No teeth are present on either margin. The fang is short, quite pointed and seems to be sinuous along its dorsal line.

The lip is flat, trapezoidal (figure 95), wider than long in ratio 10 : 7, not thickened at the end, but provided with a few short hairs. The sternum is longer than wide in ratio 28 : 23, transversely truncated in front, bluntly pointed behind. The lateral margin of the posterior

end of the sternum is distinctly concave, so that the end of the sternum has the appearance of a nipple. The surface of the sternum is distinctly, though not strongly convex and sparsely clothed with short, simple hair directed forward and inward. The first coxae are the largest and are wide apart. The fourth coxae are next in size and are separated by about their width. None of the trochanters are notched. The outer edges of the maxillae are almost parallel. Their front is truncated and bears a serrula. The inner edge is angular, with a heavy scopula on its anterior, short portion. The long, posterior portion of the inner edge appears to be somewhat concave.

| Legs | Femur | Pat.+Tibia | Metatarsus | Tarsus | Total |
|---|---|---|---|---|---|
| I | 1.00 | 1.17 | 0.62 | 0.25 | 3.04 |
| II | 0.75 | 0.95 | 0.65 | 0.25 | 2.55 |
| III | 0.67 | 0.65 | 0.45 | 0.25 | 2.02 |
| IV | 0.87 | 1.00 | 0.60 | 0.30 | 2.77 |

| Leg formula | 1 | 4 | 2 | 3 |
|---|---|---|---|---|
| | 2.3 | 2.1 | 2.0 | 1.6 |

Width of first patella 0.20 mm. First tibial index 17.

Width of fourth patella 0.16 mm. Fourth tibial index 16.

First tibia with 2–2–2–1p ventral spines of unusual length (figures 107 and 108). First metatarsus with 2–2–2 ventral spines, the end of the proximal pair reaching beyond the base of the second, while the considerably shorter third spine still reaches far beyond the end of the metatarsus. The second leg has a similar arrangement of spines, but in this case even the retroventral spines are still longer. The fourth tibia has 0–2–2 ventral spines, both pairs very small and easily overlooked. All tarsi have three claws, but the third claw is small and difficult to see among the hairs situated at the end of the tarsus and partly hiding it. The upper claws (figure 103) are similar and have six long teeth on the anterior tarsi, but only five on the fourth tarsi (figure 105). Whether the third claw is smooth or has a single tooth as shown in the figure, cannot be decided with certainty on account of the hairs which partly obstruct the view. A single trichobothrium can be seen on the anterior tarsi. There may be two trichobothria, one behind the other on the metatarsi, but I do not feel sure about it. There is a flat pocket of air there, the edge of which easily may be mistaken for a trichobothrium in certain light. One thing is sure, however, that there is no row of trichobothria on either joint.

The anterior surface of the chelicerae is covered with long, stout, curved bristles, standing at considerable intervals. There are similar, but shorter and less stout bristles at the end of the trochanter on all legs. The legs themselves have no bristles, but are clothed with simple

hair standing in rows as shown in figure 107. These hairs become stouter on the tarsi of the first and second pair of legs. The end of these tarsal hairs is blunt. There are no serrated bristles of any kind on any joint of the legs, nor any plumose hair.

The abdomen is neatly ellipsoidal, only slightly flattened on its ventral surface. As shown in figure 90 it overlaps the posterior end of the carapace considerably. It is 1.6 mm. long, 1.15 mm. wide. On its sides it appears to be slightly corrugated and the individual corrugations continue from the one side to the other by passing across the dorsal surface of the abdomen near its end. The left half of the ventral surface of the abdomen is pressed in by a large air-bubble which obstructs its view. But on the right side the view is clear and one can see plainly the corrugated cover of the right lung and the lung-spiracle. The tracheal spiracle cannot be seen partly because of the distortion due to the air-bubble, partly perhaps because tracheal spiracles are extremely rarely visible in amber spiders. One thing seems to be sure that the spider did not have a pair of tracheal spiracles, nor a spiracle far in advance of the spinnerets, for in such cases the arrangement of the hair appears to be modified by the presence of the spiracle. No such change in the arrangement of the hair on the venter of the abdomen can be noticed. The conclusion seems to be fairly certain that the tracheal spiracle was single and was situated close to the spinnerets, unless indeed it was altogether wanting, a possible, but extremely rare case in spiders.

A colulus is definitely wanting. The six spinnerets form with their bases almost a circle (figure 96). The anterior pair is cone-shaped but their second joint is in the shape of a very low cylinder the top of which is circular and quite flat (figure 97). In good light and by placing the specimen at a proper angle one can see on this flat surface 13 small spinning tubes and one large one arranged as shown in the figure, the large tube pointing toward the plane of symmetry. The large tube is of the type of so-called spigots, but the smaller tubes are also short and much of the same shape. The anterior spinnerets are more or less in contact with each other not only at their base, but along the plane of symmetry as well. They are easily twice as stout as the posterior pair. The latter are also cone-shaped and two-jointed. The top of their second joint is also round and flat and bears one large and 11 small spinning tubes (figure 98). The large spigot is directed toward the plane of symmetry. The median spinnerets can be seen, but not well enough to make out the spinning tubes. The anal tubercle is large, single jointed, covered like the spinnerets with stout, blunt, curved hairs. The ventral and dorsal surfaces of the abdomen are clothed with short, simple hair. This hair is even shorter than that on the sternum, so that it may be seen only in proper lighting.

Both palpi are well preserved, but on account of their position their structure is difficult to make out. It is quite certain that the patella is larger than the tibia and has neither spines nor apophyses. The tibia also has no apophysis, but it has 1–1 dorsal spines (figure 91) the first of which is of considerable length and fairly stout. The cymbium is more or less bowl-shaped. Under its end which is almost rectangular as shown in figure 92, a pair of black, triangular apophyses can be seen. The embolus seems to form a spiral, three turns of which can be seen in side view, but the presence of white emulsion on the bulb makes the picture indistinct.

The carapace, lip, sternum and legs must have been in life of a dark brown color which is still present in the chitin. Through a chance trick air filled the space between the chitin and the amber. When a beam of light strikes the surface of this sheet of air, the spider appears to be silvery grey. When the beam is directed so that it penetrates through the air, the spider appears to be dark brown. The chelicerae and maxillae are almost black. The abdomen very light yellow. Notwithstanding its small size, the spider has the appearance of a very sturdily built creature and, for a male, the relative length of its legs is much shorter than is the usual case in orb-weavers.

The *Paratype* is also a mature male of about the same size and appearance. In some respects it is not as well preserved as the type, and the amber is full of bubbles and planes of cleavage reflecting light. Besides, the venter is partly coated with white emulsion. All this makes its examination tedious and slow and photography very difficult. The maxillae, lip, sternum and coxae are not at all visible. But the important structures, such as the legs with the enormous ventral spines, the claws and the spinnerets are perfectly visible. The palpi are also as well preserved as in the type, so that there can be no doubt whatsoever about the conspecificity of the two specimens.

Total length measured as sum of the length of the carapace and of the abdomen is 2.75 mm. The abdomen is twisted out of its proper position, and does not overlap the posterior edge of the carapace as in the type. On the contrary, it leaves the petiolus exposed to view and makes the measurement of the total length of the specimen greater that it would be, if the abdomen were in its proper position.

Carapace 1.25 mm. long, 0.95 mm. wide between second and third coxae. Head 0.60 mm. wide. Eye group 0.35 mm. wide. The disposition of the eyes and the shape of the carapace is the same as in the type. The thoracic groove is longitudinal, situated on the posterior declivity at about its own length behind the highest point of the carapace. There are a few simple hairs on the head, but none on the thoracic portion the surface of which is finely rippled all over, giving it a silvery appearance.

The eye group is difficult to study. The diameter of the outer surface of each eye is considerably greater than that of its inner surface. For example the outer disc of the PME has a diameter of 0.09 mm., the inner disc 0.05 mm., leaving for the iris a circular band fully 0.02 mm. wide. When one studies the eyes at one angle of the incident beam and sees only the inner meniscus, the eyes appear small and far apart. When the ray is so directed as to illuminate only the outer meniscus the eyes appear of normal size, as they would appear in life with the iris present. The measurement of the eye group is easier by taking the distances between the centers of the eyes, the centers remaining the same for both the outer and inner meniscus. Thus measured the distance between the centers of the two PME is 0.10, between the centers of a PME and a PLE of the same side 0.11 mm., i.e. the median eyes of the second row are slightly nearer together. The quadrangle of medians is distinctly narrower in front than behind and considerably wider than long. The AME are the smallest, then the ALE, while the eyes of the second row are the largest and are all four of the same size. The lateral eyes on each side of the eye group are on a common, elongated tubercle. The second row is distinctly wider than the first. The clypeus is equal to one half the length of the quadrangle. Behind the carapace the dorsal sclerite of the petiolus is in plain view.

Only the base of the chelicerae are visible, but the boss stands out clearly.

| Legs | Femur | Pat.+Tibia | Metatarsus | Tarsus | Total |
|---|---|---|---|---|---|
| I | 1.05 | 1.10 | 0.55 | 0.25 | 2.95 |
| II | 0.80 | 0.85 | 0.55 | 0.25 | 2.40 |
| III | 0.65 | 0.70 | 0.40 | 0.25 | 2.00 |
| IV | 0.90 | 0.90 | 0.55 | 0.25 | 2.60 |

| Leg formula | 1 | 4 | 2 | 3 |
|---|---|---|---|---|
| | 2.4 | 2.1 | 1.9 | 1.6 |

The femur of the first pair of legs is considerably stouter than those of the other legs and is slightly compressed laterally. The upper claws are similar, curved, with long teeth. The third claw is smooth and small, difficult to see. The spination of the legs is the same as in the type and the ventral spines of the first and second pair of legs stand out clearly. (Figures 100 and 101.)

The abdomen is 1.5 mm. long, 1.05 mm. wide. The entire group of spinnerets is plainly visible and excellently preserved. The spinnerets have the same structure as in the type, but what makes the paratype of particular interest and of great importance is the fact that several threads of silk are still attached to two of the spinnerets (figure 99).

Examination under higher power (figures 104 and 175). reveals that each thread has a row of viscous droplets of the same appearance as those seen in any Recent orb-weaving spider. Some of the droplets retained their original shape of a globule, others lost their individuality by fusing into a single, large globule. This is the common fate of Recent viscous droplets on spiders' threads, whenever they are brought in contact with a surface or substance to which they may adhere, the strength of the attraction being greater than the surface tension of the globules. It is remarkable and fortunate indeed that amber resin did not have that effect, for the preservation of the viscous threads makes it quite certain that Ephalmator used viscous silk for the capture of its prey. One can see even the thread to which the droplets are attached. The spider must have produced the silk when it was caught in the sticky resin and before it died. The globules stop not far from the spinning tubes, but the last short stretch of silk is free of droplets. The presence in amber of viscous silk was noticed and described already by Bachofen-Echt in 1934. But he gave only a figure of the silk, the question of its producer was left unanswered. Bachofen-Echt ascribes the silk to an orb-weaver of an unknown family, but he neither figures, nor describes the spider and the inference is that the piece of amber did not contain a spider. Whether Ephalmator described here was an orb-weaver or used viscous silk only for enswathing its prey, remains of course problematic. But the production of viscous threads by Ephalmator stands beyond dispute.

## 41 Family EUSPARASSIDAE

### Subfamily EUSPARASSINAE

### Genus CADUCEATOR Petrunkevitch 1942

Type *C. minutus* Petrunkevitch

#### CADUCEATOR QUADRIMACULATUS spec. nov.

Figures 125–127, 202 and 203

Type, specimen No. 7221, (figures 202 and 203), Mus. Comp. Zoölogy, Harvard, mature female. The type and only specimen of this interesting Baltic Amber spider resembles so closely in coloration and in many structural details the species which Koch described under the name of *Ocypete triguttata* referred by me in 1942 to the then new genus Ablator of the Family Clubionidae, that I was led at first to believe that the specimen described below belonged to the same

species and differed only in sex. The Genus Ocypete was proposed by Koch and is now generally regarded to be a synonym of the genus Heteropoda of the Family Eusparassidae. Heteropoda, like other Eusparassidae, has distinctly laterigrade legs. Of the legs of his *Ocypete triguttata* Koch merely says that their length agrees with that of the other species (of the genus): "Die Beine stimmen in der Länge mit den andern Arten überein; sie sind dünn und nicht sichtbar behaart." (p. 86). He does not state that they are laterigrade, nor does his figure 141 on Plate XVI show a laterigrade spider. Moreover, Menge, in his footnote on page 86, states that both Koch's description and his figure are incorrect and that the spider belongs to the Genus Pythonissa. "Offenbar gehört dieses hübsche Thierchen zur Gattung Pythonissa. Der abgesetzte, mit von beiden Seiten her aufliegenden Härchen bedeckte Kopf, das gewölbte Rückenschild, der mit feinen Haarschüppchen bekleidete, gewölbte Hinterleib, die nackten Füsse, die kurzen Fusskrallen sind Merkmale die Ocypete nicht zukommen. Die Augenstellung ist allerdings ähnlich aber nicht gleich, denn die vordere Augenreihe ist etwas rückwärts gebogen und steht mit der hintern auf der wenig nach vorn geneigten Kopffläche. Die Abbildung Fig. 141 ist nicht ganz genau. M." Menge studied Koch's original specimen and no other specimen of the species was known at the time. The Genus Pythonissa was also proposed by Koch and is now generally regarded to be a synonym of Gnaphosa, a representative of the prograde Family Drassodidae (=Gnaphosidae). Menge's footnote, especially his reference to the scales covering the abdomen, and Koch's figure and description of the palpi induced me in 1942 to refer the two specimens in the collection of the British Museum to the species *triguttata*, and to place it in the Family Clubionidae, a family closely related to the Drassodidae by its external characters. The type (figure 125) of *Caduceator quadrimaculatus* is a beautifully preserved specimen showing all important characters except the claws which can be studied only in reflected light under low power because the legs are flexed under the body. But the legs are distinctly laterigrade in their proportions and are even held in a laterigrade manner, which is not always the case in specimens preserved in amber because they struggled in an attempt to free themselves of the sticky medium in which they were caught.

Total length 3.43 mm. Carapace 1.50 mm. long, 1.35 mm. wide, with a short, line-like thoracic groove the anterior end of which is 1.12 mm. behind the anterior edge of the carapace, i.e. at a considerable distance from it. The posterior declivity begins immediately behind the thoracic groove and is covered by the anterior portion of the abdomen. The posterior edge of the carapace is therefore not visible.

The lateral edge is distinctly flattened or margined as far as the outer edge of the chelicerae, a peculiarity which it shares with *Ablator triguttatus*. The eye group shown in figure 126 is distinctly narrower than the head. Both rows are slightly recurved and the first row is considerably shorter than the second row. The posterior lateral eyes are about twice as large as the other eyes which are more or less equal. Exact measurement, however, is difficult because the individual eyes are visible only in certain positions relative to the source of light and no more than five eyes can be seen at once in any position. The figure is therefore a composite one and only partly drawn with the aid of the camera lucida. But it seems certain that the quadrangle of medians is much narrower in front than behind. The surface of the carapace to the outside of the white bands is very finely rippled and quite devoid of hair. The median dark band enclosed between the two white bands is very sparsely clothed with quite short, light colored, simple hairs with large intervals between them. The median band is as wide as the eye group from which it extends backward to the thoracic groove. The two white bands unite in a curve across the thoracic groove and, since they are wider than the length of the groove, the posterior edge of the curve disappears under the overlapping abdomen. The color of the white bands is due to simple, white hair which densely clothes this region of the carapace. The hair is recumbent, directed downward and outward and covers the underlying chitin completely. No scales are on the carapace.

The chelicerae are short, stout, parallel and vertical. Neither their armature, nor the fangs can be seen. The lip is longer than wide and reaches beyond the middle of the more or less parallel maxillae. The sternum (figure 127) is oval, longer than wide in ratio 4 : 3, truncated in front, bluntly pointed behind. Its sides are slightly excavated opposite each coxa. The surface is slightly convex and sparsely clothed with short hair. The first coxae are wide apart, the fourth coxae are separated by about their width. There are no scopulae on the legs and the spines are few, short and difficult to see. There are 1–1 dorsal spines on all femora, 2–2 ventral spines on tibiae and metatarsi. On the fourth tibia one can see a single retrolateral spine. The claws are well visible, but as already explained cannot be studied under high power.

| Legs | Femur | Pat.+Tibia | Metatarsus | Tarsus | Total |
|---|---|---|---|---|---|
| I | 1.05 | 1.35 | 0.85 | 0.55 | 3.80 |
| II | 1.10 | 1.30 | 0.85 | 0.60 | 3.85 |
| III | 1.05 | 1.15 | 0.85 | 0.55 | 3.60 |
| IV | 1.10 | 1.45 | 1.25 | 0.65 | 4.45 |

| Leg formula | 4 | 2 | 1 | 3 |
|---|---|---|---|---|
| | 2.9 | 2.5 | 2.5 | 2.4 |

The abdomen is 2.15 mm. long, 1.35 mm. wide about three fifths of its length from the anterior end. Anteriorly it is distinctly concave, its posterior end is rounded, its dorsal surface distinctly flattened. This entire surface is densely clothed with short, recumbent hair of two kinds. Most of the surface is clothed with dark yellowish brown hair which is replaced in four spots by white hair. One of these spots is at the anterior end, another at the posterior end of the abdomen. The pair of white spots in the middle of the abdomen are elongated, oblique and almost in contact with each other in the plane of symmetry. (Figure 125.) There are no scales. The ventral surface is golden brown, sparsely clothed with light colored hair. The entire surface behind the epigynum is transversely corrugated. The spinnerets are well visible and even the tips of the median pair can be seen. The anterior and posterior pair are about equal, short and stout. The epigynum (figure 127) is very large and shiny, with a pair of round, clearly visible receptacles.

## Genus ADULATRIX Petrunkevitch 1942

Type *A. fusca* Petrunkevitch

The reader will find in my Study of Amber Spiders a key to the genera of the Subfamily Eusparassinae, four of which are found in the Baltic Amber. Only one of the four is represented in the Recent fauna. A key to the four species of Adulatrix is also given in the same paper. Only *Adulatrix parva* Petrunkevitch is represented in the collection of the Museum of Comparative Zoölogy. Since the description of the types belonging to the British Museum was made by me in great detail, nothing new could be added here. But specimen No. 7662 is so unusually well preserved that I give a photograph of it here in figure 208.

## Genus ZACHRIA L. Koch 1875

Type *Z. flavicoma* L. Koch

The genus Zachria was established by L. Koch for a species of Recent spider living in Australia. In 1946 I referred to this genus, a Baltic amber species, *Z. peculiata*, which resembles in some of its characters species of the genus Adulatrix, but differs from the latter by the order of its legs and by the presence of a scopula on all four tarsi. The specimen which I refer here to the genus Zachria and which is described in detail below, is unfortunately in such condition that its generic affiliation is far from certain. The specimen was badly mishandled

by whoever owned it before it was purchased by the Museum and placed in my hands for study. The entire roof of the carapace was polished off, leaving only a narrow strip and the first row of eyes, but fortunately enabling one to see the complete circumference and measure its length and width. Several legs are also mutilated and the first pair was evidently lost by the spider before it was engulfed in the still liquid amber resin. Of the second right leg the metatarsus and tarsus have been polished off and the second left leg is preserved only to the end of the patella. The right third leg and both fourth legs are fortunately complete. Yet the identification of the genus depends upon the configuration of the entire eye group and the relative size, spination and other features of the first and second pair of legs. But while the generic affiliation remains therefore only as tentative and probable, the specific characters are so well and so completely preserved, that there should be no difficulty in recognizing the species in the event another specimen of the same sex were found.

### Zachria desiderabilis spec. nov.

Figures 109–118 and 205

Male. Type, specimen No. 7139.

Total length with chelicerae 5.6 mm. Carapace 3.25 mm. long, 1.50 mm. wide in front, 3.00 mm. wide between second and third coxae. The shape of the carapace is shown in figure 111. It resembles a great deal that of *Adulatrix fusca*. The area which is missing is outlined in the figure. The first row of eyes is distinctly shorter than the width of the carapace in that region, being only 0.87 mm. long. As the figure 113 shows on a larger scale, the lateral eyes are much larger than the median ones. The latter are difficult to see and are somewhat nearer the lateral eyes than each other. The second row is missing, but was presumably somewhat longer than the first. The clypeus is very difficult to measure and is over three diameters of the anterior median eyes (or since the anterior lateral eyes are much better visible the clypeus may be stated to be equal to their diameter and a half.) The surface of the carapace is covered with short hairs directed forward and inward. On the clypeus one can see a transverse row of bristles.

The chelicerae are stout and short, with parallel outer edges and parallel inner edges as far as their middle, from thence they diverge as shown in figure 113. The shape of the fangs may be seen in a certain position of the specimen, but the armature of the margins is not visible. The sterno-coxal region is shown in figure 117. The lateral outlines of

the sternum are not clear, but the anterior end is plain enough and appears to be slightly emarginate. The curved anterior edge of the lip can be seen without difficulty because the lip happens to be of a grey color, whereas the maxillae and the sternum are more or less yellow. But the proximal end of the lip is not as plainly visible. It seems, however, to be narrower as shown in the figure. The posterior end of the sternum is drawn out into a blunt point separating slightly the fourth coxae. The first coxae are wide apart, but not as wide as the second pair, and the sternum is also widest between the second coxae. While its width cannot be measured exactly, it seems to be as wide as long. Its surface, where not appearing bare in consequence of loss of pubescence, reveals the presence of fairly stout and rather short hair.

| Legs | Femur | Pat.+Tibia | Metatarsus | Tarsus | Total |
|---|---|---|---|---|---|
| I | — | — | — | — | — |
| II | 3.57 | 4.86 | — | — | — |
| III | 3.00 | 3.71 | 2.71 | 1.28 | 10.70 |
| IV | 3.29 | 3.86 | 3.15 | 1.45 | 11.75 |

The following spines can be seen. On the second femur 1–1 dorsal. On the second tibia 2–2–2 ventral spines of which the first pair does not reach the base of the second pair, while the latter just reaches the base of the third pair. In other words these spines are long, but not exceptionally so.

On the third leg: femur dorsal 1–1, prolateral 1–1, retrolateral 1–1, ventral 0, but it is possible that a third spine is present on the three surfaces bearing spines. Patella retrolateral 1, elsewhere 0. Tibia dorsal 0, prolateral 1–1, retrolateral 1–1, ventral 2–2–2. These spines are much longer than the corresponding ones on the second leg. Metatarsus dorsal 0, prolateral 1–0–0, retrolateral 1–0–0, ventral 2–2–0. The metatarsal spines are as long as the tibial spines.

On the fourth leg: femur dorsal 1–1–1, prolateral 0–1–1, elsewhere 0. Patella 0. Tibia dorsal 0–1, prolateral 1–1, retrolateral 1–1, ventral 2–2–2. The length of these spines may be best judged by examination of figure 116 on which they are drawn to scale. Metatarsus dorsal 0, prolateral 1–1–1, retrolateral 1–1–1, ventral apparently 2–2–2, but this is not quite certain on account of the position of the leg in the amber.

The third tarsus is thickly scopulate along its entire length, the third metatarsus in its distal quarter, though a less dense continuation of it may be traced almost to the base. The fourth tarsus is also scopulate along its entire length (figure 112) though not as densely as the third. The fourth metatarsus has no scopula. The surface of the femora is covered with fine, short, recumbent hairs, that of the tibiae

and metatarsi and tarsi with considerably stouter and somewhat longer hair which stands at an angle. Under the second tibia one can see a single row of seven erect hairs. Ungual tufts can be seen on the fourth tarsi. On the third tarsus they have been polished off. Trichobothria may be seen on the fourth tarsi and increase in length distally. The two claws are similar and each has a long row of 10 teeth (figure 114).

Although somewhat shrunken, the abdomen is very well preserved. It is 3.14 mm. long, 1.86 mm. wide, rounded at both ends, but considerably wider in front than behind. The back is densely clothed with short, brown hair. The sides are longitudinally wrinkled, the rows of wrinkles extending from the spinnerets to the genital fold. The trapezoidal field between the wrinkles, occupying the median portion of the venter, is free from wrinkles. The entire venter is densely clothed with short, brown hair.

The spinnerets are well visible in strong light (figure 118) and appear to be cone-shaped. The median pair is not visible. No colulus is present. A circular wrinkle of the integument surrounds the entire mamillary group.

The most characteristic specific feature of the specimen is of course its palpi. Both are well visible in various positions. The femur (figure 115) is considerably wider in front than at its base. Five stout spines can be seen on its dorsal surface. One of these is in the middorsal line, somewhat beyond the middle. The other four form a transverse row close to the end of the femur. A middorsal spine is also present on the patella. The tibia is characterized by the presence of two apophyses (figure 109). One of these is ventral and simple, thorn-like. The other is retrolateral and very peculiar. It has the appearance of a wide scoop, the edge of which is prolonged into a thin process. The scoop arises from the wall of the tibia near its base and has, besides several long bristles, a long, stout spine bent near its base at right angles and directed with its main portion forward (figure 110). The position of the two apophyses is rather unusual inasmuch as tibial apophyses are more commonly apical or subapical. Among amber spiders a similar position of apophyses was described by me in *Eomatachia latifrons*, a cribellated spider of the family Psechridae. The copulatory apparatus is also characteristic. The part inside which the sperm receptacle is situated, is more or less bean-shaped, dark brown, almost black. Between it and the cymbium a curved sheath is situated. This sheath is almost transparent and is evidently for the protection of the embolus which is of the same length as the sheath, but black and needle-like. The sheath is in the shape of a gouge, more or less semicircular in transverse section.

## Subfamily SPARIANTHIDINAE

### Genus EOSTAIANUS, new

This genus seems to be closely allied to the Oligocene (Baltic Amber) Genus Eostasina and the Recent genus Staianus. It may be distinguished from the former by having, like Staianus, two pairs of ventral spines on the first and second metatarsi, whereas Eostasina has three pairs. From the Recent Staianus it differs by its anterior median eyes which are as large as the lateral eyes, whereas in Staianus they are nearly half the size. The characteristic feature of these genera is the presence of only ventral spines on the first and second tibia and metatarsus, and their length, stoutness and situation on distinctly elevated sockets. The characters of the genus may be given as follows: Carapace longer than wide, convex, highest in the region of the thoracic groove which is longitudinal. Head much narrower than thorax. Eye group nearly as wide as head. Clypeus low. First row of eyes shorter than second row. Eyes of first row contiguous, those of second row evenly spaced and all eyes of about the same size. First coxae wide apart, fourth coxae separated by about half their width. Legs in order 4132. Scopulae wanting. Ventral spines on first and second tibia and metatarsus stout, long and elevated on distinct pedestals. First tibia with three pairs, first metatarsus with two pairs of ventral spines. Type: *E. succini* nov. spec.

#### EOSTAIANUS SUCCINI spec. nov.

Figures 119–124 and 207

*Type.* Immature female No. 7997a, complete and well preserved specimen in fairly dark amber. The legs of the right side placed as in prograde spiders, those of the left side, except the first, placed at more or less right angles to the body as in laterigrade spiders. The proportions of the legs are similar to those of Recent Eusparassidae and there seems to be no doubt as to the family and subfamily to which the species belongs.

Total length 3.57 mm. Carapace (figure 121) 1.50 mm. long, 1.20 mm. wide between second and third coxae when the specimen is measured in a position in which its ventral surface is in the horizontal plane. Width of head in the eye region 0.65 mm. Width of first row of eyes 0.37 mm., of second row 0.55 mm. Abdomen 2.0 mm. long, 1.3 mm. wide. The face is shown in figure 123, the eye group in figure 119.

| Legs | Femur | Pat.+Tibia | Metatarsus | Tarsus | Total |
|---|---|---|---|---|---|
| I | 1.00 | 1.55 | 0.75 | 0.50 | 3.80 |
| II | 1.10 | 1.35 | 0.65 | 0.50 | 3.60 |
| III | 1.10 | 1.20 | 0.80 | 0.55 | 3.65 |
| IV | 1.30 | 1.50 | 1.20 | 0.55 | 4.55 |

| Leg formula | 4 | 1 | 3 | 2 |
|---|---|---|---|---|
| | 3.0 | 2.5 | 2.4 | 2.4 |

Fourth femur curved upward dorso-ventrally, i.e., is concave on the dorsal surface, convex on the ventral surface.

*Spines.* First leg, femur dorsal 1–1, prolateral 1 stout spine in middle and 1 small and slender spine three quarters from base. Tibia ventral 2–2–2–1p on left leg, 2–2–2 on right leg. In both rows the spines are elevated on little pedestals and the first pair is near base, yet reaches with its end the base of the third pair. The prospines are long and stout, the retrospines slightly shorter and more slender. Metatarsus ventral 2–2. There are no other spines on the first leg. Second leg, femur dorsal 1–1–1, (the third spine very small). Tibia ventral 2–2–1p on right leg, 2–2 on left leg. Metatarsus ventral 2–2. No other spines on second leg. Third leg, femur dorsal 1–1–1 (the third spine small). Patella dorsal 0–1, retrolateral 1. Tibia dorsal 1–1, prolateral 1–1, retrolateral 1–1, ventral 1p–2–1p. Metatarsus dorsal 1–1–2, prolateral 1–0–1, retrolateral 1–0–1, ventral 2–2. No other spines on third leg. Fourth leg, femur dorsal 1–1–1 (the third spine small), retrolateral 0–0–1. Patella dorsal 0–1, retrolateral 1. Tibia dorsal 1–1–1 (the third spine very small), prolateral 1–1, retrolateral 1–1, ventral 0–1r–2 (the first spine stout and long, situated almost in the middle of the tibia, the apical pair small). Metatarsus dorsal 1–1–1, prolateral 1–1–1, retrolateral 1–1–1, ventral 2–2–2 (the five subapical spines forming a verticellum). There are no other spines on the fourth leg.

The ventral spines on all tibiae are stout and long (figure 124). The dorsal spines on all femora are also long, but more slender.

On the palp one can see on the patella 1 dorsal and 1 prolateral spine, on the tibia 1–1 dorsal and 1–1 prolateral spines, on the terminal joint three spines of which one is prolateral, but the position of the other two is uncertain on account of the position of the joint. There is very little and quite inconspicuous hair on the legs, but trichobothria seem to be numerous. Under microscope under fairly high magnification one is able to see that they are irregularly arranged on all tibiae and some may be seen on the metatarsi. The trichobothria are only slightly longer than the hairs and can be recognized only because they arise from the center of a disc-like base. There are no scopulae on any legs. Nor can be any claw tufts seen, although there are only two

claws. They are best seen on the second right leg (figure 120) where a slight dissimilarity is noticeable.

## 42 Family THOMISIDAE

The classification of this family has been changed several times. Simon recognized six subfamilies. The first two subfamilies he separated from the others on the basis of the structure of their maxillae, pointed in Aphantochilinae and Strophiinae, more or less truncated in others. The Stiphropodinae he separated from the other three subfamilies by the swollen tarsi and minute claws. Among the characters by which he separated the Stephanopsinae from the last two subfamilies (Misumeninae and Philodrominae) he mentions the fact that in the former the first pair of legs is the longest, while in the latter two the second leg is the longest. This character applies equally well to all subfamilies because the first leg is longest only in the Stephanopsinae. In my own key published in my Catalogue of American Spiders in 1939 I recognized seven subfamilies, having removed from the Misumeninae all genera possessing true claw-tufts and assigned them to the Subfamily Dietinae. But I omitted to mention the relative length of the legs in the key. As an external character unsupported by any evidence of its correlation with internal organs, it has no greater value than the shape of the maxillae or of the tarsi. But this applies to all external characters. On the other hand it seems to be fairly constant. At least in no genus of the Stephanopsinae is the second leg longer than the first and only in two genera the two pairs seem to be of the same length. Moreover, it is a very convenient character, especially in fossil species. For all these reasons I believe it advisable to segregate in the Subfamily Stephanopsinae all Recent and fossil genera of Thomisidae in which the first leg is longer (or at least not shorter) than the second. With this character as the chief basis for the separation of the Subfamily Stephanopsinae the status of Koch's genus Syphax must also be changed. In 1942 I placed it in the Subfamily Dietinae on the strength of the presence of claw-tufts. The genera of fossil Thomisidae, Facundia, Filiola and Medela, placed by me in 1942 in the Subfamily Misumeninae because of the lack of claw tufts must be also reconsidered in this connection. In Facundia the first leg is much the longest and the genus should be therefore regarded as belonging to the Subfamily Stephanopsinae. In Filiola and Medela the fourth leg is clearly the longest. This is a very unusual thing. So far as I am aware the fourth leg among Recent Thomisidae is the longest only in the genera Aphantochilus, Thanatus and Tibellus.

In the genus Bucranium, according to its author O. P. Cambridge, the first and fourth legs are subequal in length (exact measurements in *Bucranium taurifrons*, the genotype and only species, are not given), while in the genus Majella also belonging to the Subfamily Aphantochilinae the first leg is the longest in the two known species. In these two Recent genera the maxillae are pointed, but their shape in the fossil Filiola and Medela is not known because in the specimens on which I based these genera the maxillae are obstructed from view by dirt and emulsion. Among the Thomisidae described below Eothanatus has also the fourth leg longest, but its maxillae are not visible. Since there is no evidence whatsoever that Filiola and Medela are in any way related to either Aphantochilus, Thanatus or Tibellus, it may be wisest to leave them *incertae sedis* within the Family Thomisidae. Koch described four Baltic Amber species of Philodromus, but Menge considered them to be Pythonissa, a genus synonymous with Gnaphosa of the Family Drassodidae (= Gnaphosidae). Menge himself established a Baltic Amber genus Anatone differing from Philodromus only by the relative size of the eyes. Neither the proportion of the legs of the two species of Anatone nor their maxillae are mentioned. The following key to Baltic amber Thomisidae is therefore applicable only to genera recognized and described by me. I may add that the spider which in 1942 I placed in the genus Misumena (a Recent genus, with many common species in all parts of the world) has great resemblance to *Fiducia tenuipes* described below, but the order of legs and the shape of the sternum is different. Already at that time I expressed the opinion that "it is possible that the amber species *M. samlandica* should be separated from the recent species and a new genus erected for it. But in that case the definition of the Genus *Misumena* would have to be revised and that does not seem to be desirable." (p. 375.) I still hold this opinion.

### *Key to Baltic amber Thomisidae*

1. The first and second pair of legs are considerably longer than the third and fourth pair . . . . . 2
– The fourth pair is distinctly the longest . . . . . 5
2. The second pair of legs is the longest. Spines and claw tufts wanting . . . . Genus *Misumena*
– The first and second pair of legs are equally long or the first pair is longer . . 3
3. The first and second pair of legs are equally long, stout, with stout spines. Claw tufts well developed. Sternum shield-shaped, longer than wide. Hair simple . . . . . Genus *Syphax*
– The first leg is distinctly longer than the second. Claw tufts wanting . . . 4

4. Legs relatively short and stout, the first leg not more than two and one-quarter times as long as the carapace. Anterior median eyes much smaller than anterior lateral eyes. Sternum suborbicular.....Genus *Facundia*
– Legs slender, first leg nearly six times as long as carapace. Eyes of first row equal. Sternum triangular.....Genus *Fiducia*
5. Eyes of first row much smaller than those of second row. Patella of all legs with strongly angular retrolateral edge. Claw tufts wanting. Integument with simple hair.....Genus *Medela*
– Disparity in the size of the eyes not great. Patella of the usual appearance. 6
6. Claw tufts wanting. Hair simple. Clypeus as high as the quadrangle. Eyes on a low, transversely elliptic tubercle.....Genus *Filiola*
– Claw tufts present, although poorly developed. Hair with a pair of basal pinnae. Clypeus much lower than the quadrangle. Eyes not on a tubercle.....Genus *Eothanatus*

## Subfamily STEPHANOPSINAE

### Genus SYPHAX Koch and Berendt 1854

Type *S. megacephalus* K. and B.

#### SYPHAX ASPER spec. nov.

Figures 128–130 and 212

*Type*, No. 7661, Mus. Comp. Zoöl. Immature female. Figure 212. Total length with chelicerae 4.15 mm. Carapace 1.70 mm. long, 1.60 mm. wide, about 0.90 mm. wide in the region of the eyes. Abdomen 2.40 mm. long, 2.25 mm. wide, evenly rounded at both ends and on sides, flattened above.

| Legs | Femur | Pat.+Tibia | Metatarsus | Tarsus | Total |
|---|---|---|---|---|---|
| I | 1.40 | 1.70 | 0.65 | 0.55 | 4.30 |
| II | 1.25 | 1.50 | 0.55 | 0.45 | 3.75 |
| III | 0.90 | 1.00 | 0.45 | 0.45 | 2.80 |
| IV | 1.10 | 1.10 | 0.55 | 0.45 | 3.20 |

| Leg formula | 1 | 2 | 4 | 3 |
|---|---|---|---|---|
| | 2.5 | 2.2 | 1.9 | 1.6 |

(NB. In *Syphax crassipes* the length of the second leg is given as equal to that of the first leg and the order of legs the same as in *S. asper*. The reason for this was that in actual measurement the first leg showed a slightly greater length in the third decimal which was omitted in the table.)

The general appearance of *S. asper* is more or less the same as that of *S. crassipes* and is shown photographically in figure 212. The carapace of the type of *S. asper* has a longitudinal tear on the right side

and the head is very dark. The shape of the carapace is easily seen in a complete outline, but the eye group cannot be seen either in reflected or in transmitted light. Only by turning the specimen around one can see in certain positions a row of four eyes, but it is impossible to decide whether it is the first or the second row and the size of the eyes can be only approximately gauged, not measured. The surface of the carapace is sparsely clothed with the same type of hair as on the back of the abdomen.

The chelicerae are stout and short, almost black in color, but their structure cannot be studied on account of the imperfections of the amber, preventing a clear view. On the other hand the lip and maxillae (figure 129) are plainly visible both in reflected and in transmitted light so that it was possible to make a drawing under microscope. The structure of the lip is very different from that of *S. crassipes* inasmuch as it has lateral excavations lacking in the latter species and is distinctly wider than long, instead of being longer than wide. The sternum is also very well visible and is longer than wide in the ratio 17 : 14. It has the same shape as in *S. crassipes*, except that the anterior excavation is gently procurved and not straight. The posterior end is pointed. The surface is sparsely clothed with short, simple hair of the same type as on the venter of the abdomen. The first coxae are wide apart, the fourth coxae are separated by about half their width.

As in *S. crassipes*, only the anterior pair of spinnerets can be seen and even these not too clearly. The group of spinnerets is situated just enough in front of the posterior edge of the abdomen to make them visible only from below. The distinctive feature of the abdomen is the appearance of its dorsal wall and the structure of its hair when examined under high power in transmitted light (figure 130). One sees then that the entire surface is covered with fine, wavy lines running in all directions. The hair is of two kinds, both sticking out obliquely above the surface and having under low power in reflected light the appearance of short rods. Under high power in transmitted light one notices at once the difference in the two types. The more numerous hair is lancet shaped and has minute spikelets on each edge. The base of the lancet is in the center of a flat, brown ring. The second type is simple hair of about the same length as the other type, but much more slender and lacking the basal ring.

The legs are stout, dark brown and have a rough appearance due to the stout hair which is simple on the femora, but covered along its full length with at least four rows of minute spikelets. There are also distinct spines present. On the femur of the first leg 1–1–1 prolateral spines, the first of which is in middle; tibia dorsal 1–1, mid-

ventral 1–1–1–1–1; metatarsus midventral 1–1–1. On the second femur 1–1 small dorsal spines on the left leg only; tibia dorsal 1–1, ventral 1p–1p–1p; metatarsus 1p–1p. On the third leg patella dorsal 1–1; tibia dorsal 1 in middle. On the fourth leg patella dorsal 1–0; tibia dorsal 1 at base. No other spines can be seen on any leg.

Two claws (figure 128), similar, stout, strongly curved, with a row of about eighteen teeth increasing in length distally. The claw tufts are well developed and composed of numerous tenent hairs, each supplied with spikelets standing at right angles to the hair along the entire edge on each side.

## Genus FIDUCIA, new

Legs laterigrade, the first two pairs considerably longer than the last two pairs. The first pair much longer than the second pair. All legs slender. Carapace very little longer than wide. Head narrow, clypeus high. Sternum triangular. First coxae very wide apart. Hair simple, setose. Claw tufts and scopulae wanting. Claws two, similar, with five teeth. Baltic amber. Type *F. tenuipes* spec. nov.

### FIDUCIA TENUIPES spec. nov.

Figures 138–141, 210 and 211

The Museum of Comparative Zoölogy has four specimens of this species, three of them females presumably in the penultimate instar, one a male in the penultimate instar. All four have the same appearance and resemble *Misumena samlandica* from which, however, the species can be distinguished by the relative length of the legs and by the eye group.

*Type.* Specimen No. 7751a. Figure 210. Total length with chelicerae about 2.75 mm., but exact measurement is not possible partly because of the heavy emulsion covering the abdomen, partly because of the twisted position of the cephalothorax. Carapace 1.0 mm. long, 0.95 mm. wide. Head 0.60 mm. wide in the region of the lateral posterior eyes, i.e. where the head joins the thorax. Width of eye group 0.45 mm. Abdomen ca. 1.55 mm. long, 1.65 mm. wide.

| Legs | Femur | Pat.+Tibia | Metatarsus | Tarsus | Total |
|---|---|---|---|---|---|
| I | 1.60 | 1.85 | 1.25 | 0.75 | 5.45 |
| II | 1.30 | 1.30 | 1.00 | 0.65 | 4.25 |
| III | 0.90 | 0.85 | 0.70 | 0.45 | 2.90 |
| IV | 1.25 | 1.25 | 0.85 | 0.50 | 3.85 |

| Leg formula | 1 | 2 | 4 | 3 |
|---|---|---|---|---|
| | 5.4 | 4.2 | 3.8 | 2.9 |

The eye group is shown in figure 138. The anterior row of eyes is recurved, the posterior row procurved and longer than the anterior row. Although plainly visible the eyes are difficult to measure. The anterior eyes are of about the same size and more or less evenly spaced. The posterior eyes are somewhat larger and also more or less evenly spaced. The lateral eyes are separated by about the radius of the anterior lateral eyes. The clypeus is strongly inclined and as high as three quarters of the length of the quadrangle which is narrower in front than behind and as long as wide.

The chelicerae are vertical, with parallel outer edges. Their first joint is 0.32 mm. long, the fang is slender and gently curved. The margins are not visible on account of the emulsion.

There are no spines on the legs, but one can see 1–1 dorsal bristles on the patellae and either 1–1 or 0–1 similar bristles on the tibiae. They are somewhat stouter and longer than the setose hair with which the legs are clothed. Claw tufts and scopulae are wanting. The claws (figure 141) are similar, with five teeth. The entire ventral surface of the body is heavily coated with white emulsion. The dorsal surface of the abdomen is also heavily coated, but the stout bristles with which it is clothed and some of which reach the length of 0.65 mm. stick out above the emulsion.

*Paratype*, specimen No. 7192, immature female. Total length with chelicerae in the position of the spider in the amber 2.5 mm., but actual length must be greater because of the considerable angle at which the cephalothorax is placed in respect to the abdomen. Nor can the carapace be measured, although the specimen is clear of emulsion. The eyes can be seen, but with some difficulty. The eye group is the same as in the type and the clypeus is plainly visible. On the promargin of the chelicerae one can see two teeth of which the proximal one is considerably larger than the distal one (figure 140). No teeth can be seen on the retromargin, but the view is not sufficiently clear to be certain in this regard. The legs are much as in the type in appearance and their proportions are as follows:

| Legs | Femur | Pat.+Tibia | Metatarsus | Tarsus | Total |
|---|---|---|---|---|---|
| I | 1.75 | 2.10 | 1.55 | 0.75 | 6.15 |
| II | 1.55 | 1.60 | 1.20 | 0.65 | 5.00 |
| III | 0.90 | 0.95 | 0.75 | 0.55 | 3.15 |
| IV | 1.20 | 1.35 | 1.05 | 0.55 | 4.15 |

*Paratype*, specimen No. 7432, immature female. Total length with chelicerae 2.7 mm. The specimen is badly damaged and although clear, cannot be measured exactly except its legs and sternum. The

latter is shown in figure 139. It is triangular, 0.65 mm. long, 0.65 mm. wide. The lip is trapeze-shaped. The first coxae are wide apart, the fourth coxae are separated by more than their width, though that may be due to the damaged condition. The legs have the same appearance as in the other two specimens.

| Legs | Femur | Pat.+Tibia | Metatarsus | Tarsus | Total |
|---|---|---|---|---|---|
| I | 1.95 | 2.15 | 1.50 | 0.75 | 6.35 |
| II | 1.50 | 1.55 | 1.30 | 0.70 | 5.05 |
| III | 0.90 | 0.90 | 0.80 | 0.55 | 3.15 |
| IV | 1.25 | 1.35 | 1.05 | 0.55 | 4.20 |

At the end of the left palp one can see a claw with a single tooth. Some of the hair on the tibiae and metatarsi stands at right angles, but it is not possible to decide whether it is due to accident or to a different type.

*Specimen No. 7704* (figure 211), immature male in the penultimate instar. Total length 3.25 mm. I refer this specimen with hesitation to the same species as the above three females. Its legs, while of the same type, seem to be somewhat stouter and in front of its palpi one can see two viscous threads of silk with a row of droplets. This silk may be there by a pure coincidence; Thomisidae do not produce viscous silk; but the appearance of the spider may be misleading and it may not belong into this family at all. The ventral surface is clear of emulsion and is shown in figure 211 photographically. The dorsal surface is not only coated with white emulsion, but a very large bubble with white walls prevents the view of the carapace except for the two lateral eyes on the right side, and the posterior edge of the carapace on the left side. The appearance of the visible portions of the carapace suggests that the spider was in the process of moulting.

| Legs | Femur | Pat.+Tibia | Metatarsus | Tarsus | Total |
|---|---|---|---|---|---|
| I | 1.40 | 1.50 | 1.00 | 0.75 | 4.65 |
| II | 1.15 | 1.25 | 0.80 | 0.60 | 3.80 |
| III | 0.85 | 0.75 | 0.60 | 0.45 | 2.65 |
| IV | 0.95 | 1.00 | 0.75 | 0.50 | 3.15 |

The bristles and hair on the legs are of the same type as in the females. The claws are not well visible, but seem to be more or less also of the same type. There are definitely shorter erect hairs on tibiae and metatarsi at fairly great intervals between the longer, inclined hairs which are much more numerous.

The chelicerae and fangs are plainly visible from below, but the

view of the margins is obstructed by emulsion. Similarly the end of the lip is covered with white emulsion so that it is not possible to say whether the lip is trapeze-shaped or triangular. The sternum is triangular, as long as wide and distinctly convex. The first coxae are very wide apart. The fourth coxae are somewhat displaced, but seem to be separated by their width. The abdomen is turned on its side, so that the spinnerets appear on the edge, on the right of the observer (actually the left of the spider). This position prevents careful study of the spinning group. The spinnerets are cone-shaped, the anterior pair somewhat longer and stouter than the posterior pair. The median pair is not visible. Between the anterior pair a colulus is present.

## Subfamily PHILODROMINAE

### Genus EOTHANATUS, new

This genus is closely related to the Recent genus Thanatus from which it may be distinguished by the (probable) order of the legs, the shorter length of the second row of eyes, the lesser development of the ungual tufts, the structure of the hair on the abdomen and the absence of bristles. Type *E. diritatis* spec. nov.

#### EOTHANATUS DIRITATIS spec. nov.

Figures 131–137, 213

*Type*, specimen No. 7441. Mature male. A rather poorly preserved and badly mishandled specimen (figures 131 and 213). The metatarsus and tarsus of the first right leg are cut off and the first left leg is completely missing making the measurements of the legs incomplete. Yet the first femur and tibia with patella are longer than the second and shorter than the fourth, making it highly probable that the order of legs is 4123, (whereas in Thanatus it is 4213). The abdomen is cut away about its middle and its ventral wall is also missing. Fortunately it is a male and the loss of the ventral surface does not affect the distinctive specific characters, but the spinnerets are completely missing. The total length of the specimen can be therefore only guessed approximately as having been ca.2.5 mm. Carapace 1.15 mm. long, 1.50 mm. wide (figure 131). Eyes in two rows, very difficult to see, but it is certain that the second row is not much longer than the first, as is the case in Thanatus. The clypeus seems to be quite low. In front view, figure 132, one can see a bristle between the posterior

median eyes and four more slender bristles in the first row as shown in the figure. The chelicerae are stout and short. The boss is clearly visible, the margins are oblique and somewhat concave. The armature of the margins cannot be seen. The sternum is shown in figure 135. It is about as wide as long, but its anterior edge is partly hidden by white emulsion. Posteriorly the sternum is drawn out into a small projection which separates the fourth coxae. The first coxae are almost as wide apart as the second pair. The legs are apparently laterigrade and all joints are cylindrical.

| Legs | Femur | Pat.+Tibia | Metatarsus | Tarsus | Total |
|---|---|---|---|---|---|
| I | 1.70 | 2.20 | — | — | — |
| II | 1.60 | 2.00 | 1.15 | 0.90 | 5.65 |
| III | 1.50 | 1.85 | 1.30 | 0.75 | 5.40 |
| IV | 1.85 | 2.25 | 2.05 | 1.00 | 7.17 |

All spines are short and slender. One can see on the femora of all legs 1–1 dorsal spines, on the third and fourth tibia 2–2–2 ventral spines and on the metatarsi 1–0 ventral spines. Apparently there are no other spines present. The claws are poorly visible. Only on the second left tarsus they can be studied under higher power and are shown in figure 137. The claw tufts are rather poorly developed and, under lower power almost escape observation on account of their resemblance to hair. All hair on legs is simple. On the abdomen, on the other hand, the hair is provided with a pair of lateral pinnae situated near the base (figure 136). In Thanatus, at least in the American species *T. coloradensis*, the abdominal hair has several pairs of similar pinnae. Another difference in the structure of the abdominal hair in these two related genera is in the manner in which the pinnae arise from the main stem. In Eothanatus the main stem is smooth, but in the Recent Thanatus it has a little shelf for the base of each pinna and the shelves extend far beyond the last pair of pinnae, so that if each available shelf had a corresponding pinna, the entire hair would be a plume. Both palpi are visible. The left palp is shown complete as viewed from its prolateral side (figure 133). It shows clearly that the femur is distinctly curved dorso-ventrally. Of the copulatory apparatus one can see the bulb and two processes arising from it. The basal one is much stouter, black, and resembles a spine or thorn. I think it is the conductor. The distal one is very thin and is probably the embolus. The right palp is figured from above to show the apical, retrolateral apophysis of the tibia. This apophysis appears to be straight in any position. (Figure 134.)

An unusual and interesting feature of the specimen is the preser-

vation of the hypodermis underlying the dorsal chitinous wall of the abdomen (figure 176). Examining it under high power one can see that the hypodermal cells are still individually preserved, but sufficiently contracted to leave a little space between each cell. Within each cell a dark body is visible, which can be interpreted only as the nucleus of the cell. It is the nucleus which is also visible at the base of each hair in places where the rest of the hypodermis has disintegrated. I have shown this in figure 136. In some cases one can even see that the nucleus is somewhat behind the socket on which the hair sits and which is more refractive, being chitinous.

## 47 Family CLUBIONIDAE

### Genus ABLIGURITOR Petrunkevitch 1942

Type *A. niger* Petrunkevitch

#### ABLIGURITOR PLUMOSUS spec. nov.

Figures 142–148, 178 and 204

*Type*, No. 7624, M.C.Z. Immature female. Figure 204.

Total length with chelicerae 2.8 mm. Carapace 1.02 mm. long, 0.95 mm. wide. Head 0.50 mm. wide, anteriorly with parallel sides which then begin to converge posteriorly in a curve and meet approximately in the center of the almost circular thoracic portion. In the median line the head is on a level with the median line of the thorax and the entire carapace is rather flat. The converging cephalothoracic sulci are shallow and appear as fine transparent lines. The eye group is considerably narrower than the head, but the individual eyes are extremely difficult to see and the drawing of their disposition (figure 148) is the result of prolonged and tedious study and not a drawing under the camera lucida as the rest of the figure. In life the surface of the carapace must have been clothed with plumoso-lanceolate hair of the same type as on the abdomen and on the legs, since one can see four such hairs. But it must have been rubbed off before the spider was caught in the liquid resin so that but for the four hairs mentioned the rest of the surface is glabrous.

The chelicerae are stout and short, directed obliquely downward, but since they can be seen only from above, nothing more can be said about them. The sterno-coxal region is so full of dirt and partly concealed by emulsion, that it cannot be studied. One thing is certain

that the first coxae are very wide apart. The fourth coxae seem to be separated by their width. Judging by a portion of the sternum which is not concealed by dirt, the sternum is very slightly convex. The abdomen is ellipsoidal, 1.70 mm. long, 1.15 mm. wide. Its dorsal surface is more or less thickly clothed with hair of unusual structure which may be called plumoso-lanceolate (figure 147). The shaft of each hair is flat, lanceolate; from three to five barbs can be seen on each hair in its proximal half. In some of the hairs longitudinal lines can be seen, running parallel to the edge of the shaft. The ventral surface of the abdomen is sparsely clothed with simple hair only. The spinnerets cannot be seen on account of dirt.

All legs are present and complete, but the left second and third legs were evidently severed while the creature struggled to free itself from the sticky resin and now lie in front of the chelicerae. An interesting feature of the legs is the preservation of most muscles which appear as very dark brown rods now lying free in the cavity of each joint.

| Legs | Femur | Pat.+Tibia | Metatarsus | Tarsus | Total |
|---|---|---|---|---|---|
| I | 0.84 | 1.13 | 0.54 | 0.36 | 2.87 |
| II | 1.08 | 1.50 | 0.75 | 0.60 | 3.93 |
| III | 0.90 | 1.13 | 0.66 | 0.60 | 3.29 |
| IV | 1.29 | 1.62 | 1.20 | 0.66 | 4.77 |

| Leg formula | 4 | 2 | 3 | 1 |
|---|---|---|---|---|
| | 4.7 | 3.8 | 3.2 | 2.8 |

The spines are very difficult to see on account of their color, much like that of the surrounding amber. Even the large ventral spines of the anterior four legs can be well seen only under high power in transmitted light. On the femur of the first right leg one can see 1–1–1 dorsal spines and since at least one spine can be seen on all other femora it seems probable that their number is the same. On the first tibia 2–2–2–2 ventral spines are present (figure 143). They are stout, long and distinctly curved, each reaching beyond the base of the following one. On the first metatarsus only one pair of stout, straight and long spines are present (figure 144). The second metatarsus is armed in a similar manner, but the second tibia differs from the first tibia in that it has three spines more and the spines are still longer and straight (figure 145). This gives the second tibia 1p–2–2–2–2–2 ventral spines as in *A. niger* and the first spine stands out at right angles, but all spines are stout and long and reach far beyond the base of the following one. On the third tibia one can see a single proventral spine on the right leg, but on the fourth tibia 1–0–1 small proventral spines are visible and on the fourth metatarsus 1–1–0 similar small proventral spines are present.

The claws are strongly curved and slightly dissimilar. Under the claws (figure 142) from four to six tenent hairs are in plain view. A row of about six very long trichobothria can be seen on the metatarsi and tarsi. The legs are clothed with the same type of plumoso-lanceolate hairs as the body. Only on the tarsi they become almost completely displaced by simple hair.

This species can be separated from the type by its much longer ventral tibial and metatarsal spines of the first two pairs of legs and by the type of its hair. In *A. niger* the abdomen is clothed with scales.

## 49 Family SALTICIDAE

This family is represented in the collection of the Museum of Comparative Zoölogy by two species.

### Gorgopis frenata (Koch and Berendt)

Figure 149

*Phidippus frenatus* Koch and Berendt, 1854.
*Gorgopis frenata* Petrunkevitch, 1942, pp. 407–417, figs. 8–11, 20–32, 517–521.

Five young specimens of indeterminable sex, one immature male in the penultimate instar and two mature males. The latter are both typical and both show the palpi clearly. But specimen 7269 (113) is especially interesting because the embolus and the conductor are separated, both clearly visible (figure 149), whereas in the hypotype of the British Museum they are completely in contact with each other. Specimen 7269 is almost complete. Only the left first and the right third leg are missing. The total length can be measured only approximately, because the abdomen lies at an angle to the cephalothorax and normally overlaps it in this species. Measured in a direct line from the vertex of the AME to the tip of the spinnerets the length is 4.57 mm. The carapace is 2.10 mm. long, 1.15 mm. wide in its widest place, but only 0.85 mm. in the region of the greatest constriction. The abdomen is 2.43 mm. long and rather thin, tapering gradually from in front backward.

| Legs | Femur | Pat.+Tibia | Metatarsus | Tarsus | Total |
|---|---|---|---|---|---|
| I | 1.50 | 1.90 | 1.30 | 0.65 | 5.35 |
| II | 1.30 | 1.40 | 0.95 | 0.65 | 4.30 |
| III | 1.00 | 1.30 | 1.00 | 0.65 | 3.95 |
| IV | 1.35 | 1.85 | 1.20 | 0.65 | 5.05 |

| Leg formula | 1 | 4 | 2 | 3 |
|---|---|---|---|---|
| | 2.5 | 2.4 | 2.0 | 1.9 |

The spines are well preserved, but the hair seems to have been rubbed off in many places.

Eolinus theryi Petrunkevitch, 1942, p. 428

Figures 214–215

The type of this interesting species is in the British Museum. The Museum of Comparative Zoölogy has six specimens which I refer to this species. Specimen No. 7284 is a mature male, specimens 7276 and 7324 are immature females, specimen 7183 is a beautifully preserved carapace of an exuvium. One specimen is a very young spiderling with the eye group clearly visible. The last specimen is a damaged one with the eye group not fully preserved and its specific affiliation for this reason not absolutely certain. The two immature females are the most interesting specimens of the lot. Specimen No. 7276 has its four left legs fully extended, giving a clear picture of their relative length (figure 215). In specimen 7324 (figure 214) the dorsal surface of the carapace and abdomen is better preserved than in any other specimen and its integument is densely clothed with hair. The eye group of both these specimens is perfectly preserved and can be studied without any difficulty.

## 50 Family SEGESTRIIDAE

### Genus Segestria Latreille 1804

Type *S. florentina* (Rossi)

The genus Segestria is widely distributed and is represented on all continents. At least six Recent species occur in Europe. Nine species have been described from the Baltic amber. Of these Koch described *S. cylindrica, S. elongata, S. nana* and *S. tomentosa*; Menge mentioned *S. cristata, S. exarata, S. pusilla* and *S. undulata*; Berland described *S. succinci*. In 1942 I was tempted to call Menge's species *nomina nuda* because of the extreme brevity of description, in each case reduced to less than a line, and the lack of drawings. Greater acquaintance with amber material makes me revise that opinion because Menge seems to have based his species on the most distinctive characters. It seems to me furthermore, that Berland's *S. succinci* on closer examination may prove to be a synonym of Menge's *S. cristata*, since both these species are stated to have a crest of bristles in the median

line of the carapace. According to Berland his *S. succinei* is "sur le céphalothorax, avec de long crins dressés, à la partie antérieure et sur les chélicères" (p. 3); and according to Menge *S. cristata* is "mit forwärts gebogenen langen Haaren auf der Mitte des Rückenschildes" (p. 74). Menge mentions no other characters, while Berland gives three figures and records the shape of the abdomen, the presence of long spines on the legs and the disposition of the eyes. Only a comparison of the two specimens can definitely settle the question of their conspecificity. The new species described below is based on characters by which it may be separated from the other nine (or eight) species as follows:

1. Abdomen almost globular, thickly clothed with hair.....*S. pusilla* Menge
– Abdomen more or less elongated.....2
2. Abdomen ellipsoidal or cylindrical.....3
– Abdomen egg-shaped, with rows of transverse wrinkles on the back.....8
3. Abdomen with rows of longitudinal wrinkles on sides. Carapace with very short hair.....*S. plicata*, new
– Abdomen without wrinkles.....4
4. Carapace with a median longitudinal crest of long bristles.....*S. cristata* Menge and *S. succinei* Berland
– Carapace only with short, recumbent hair.....5
5. Abdomen cylindrical. Legs very short....*S. cylindrica* Koch and Berendt
– Abdomen distinctly stouter in middle.....6
6. Terminal joint of palp with a longitudinal groove and numerous bristles *S. tomentosa* Koch and Berendt
– Not so.....7
7. Carapace wide. Head not elevated. Legs long. Hair on abdomen coarse *S. elongata* Koch and Berendt
– Carapace of the same shape. Legs somewhat shorter. Hair on abdomen fine.....*S. nana* Koch and Berendt
8. Transverse abdominal wrinkles straight.....*S. exarata* Menge
– Transverse abdominal wrinkles undulating.....*S. undulata* Menge

## Segestria elongata Koch and Berendt

### Figures 156–159, 168–172

*Segestria elongata* Koch and Berendt, 1854, p. 72, pl. vii, fig. 65; Petrunkevitch, 1942, p. 439, figs. 124–128, 562, 568.

The Museum of Comparative Zoölogy has of this species four specimens, two of which are exuvia. *Specimen No. 7336b* (figure 168) is in perfect condition with all legs complete, and both the dorsal and the ventral surfaces in plain view. Total length with chelicerae 4.14 mm. Carapace 1.57 mm. long, 1.36 mm. wide. Abdomen 2.14 mm.

long, 1.29 mm. wide. Three pairs of legs directed forward. The margins of the chelicerae are unfortunately obstructed from view by the palpi, and the spinnerets are somewhat coated with white emulsion, so nothing new can be added to my original description of the species.

*Specimen No. 7180* is considerably smaller, being only 3.2 mm. long. It is complete and rather dark in color.

*Specimen No. 6784* is an exuvium, complete but for the loss of the first left leg and partial loss of the second, third and fourth left legs. In all other respects the specimen is perfect and can be studied and measured without difficulty. The abdomen, of course, is shrivelled, as is the case in all exuvia of Recent spiders, unless they are immediately preserved in weak alcohol. The specimen is shown photographically in figures 169–172. It is in many respects an important and interesting specimen. The margins of the chelicerae are plainly visible. The promargin (figure 157) is provided only with a scopula. The retromargin (figure 156) has no scopula, but is armed with two teeth, the proximal of which is by far the largest. The sternum (figure 158) is typical of the genus inasmuch as it is provided with four pointed spurs on each side for the articulation with the coxae as shown in figure 159. The maxillae and lip are also plainly visible and typical of Segestria. But the most interesting features of the exuvium are: 1) the presence of the complete foregut (figure 172) normally shed by spiders at each molt, but easily lost when the exuvium dries up; 2) the presence on the first right leg beyond the tibia of a single joint without claws (figure 170), instead of two joints with claws, showing that the spider was able to regenerate an injured leg without autotomizing it; and 3) the discrepancy in the size of the lenses of the two anterior lateral eyes, an unusual monstrosity presumably badly affecting clear vision (figure 171).

*Specimen No. 6789* is a much less perfectly preserved exuvium.

### Segestria plicata spec. nov.

Figures 150–155, and 173

The M.C.Z. has four specimens of this species, one of which is apparently a mature female and the others immature specimens of varying age.

*Type*, specimen No. 7436, mature female. Figures 150–154 and 173.

Total length in the position in which the spider lies in the amber 7.15 mm. Presumably the real length is slightly smaller, because the abdomen is severed from the carapace and is separated from it by 0.5 mm. The spider lies on its right side and is unfortunately not

complete. The end of the right palp is present, but the middle evidently cut off by polishing. Similarly, the first and second pair of legs are incomplete due to the same cause. The carapace is partly obstructed by the legs, but can be measured exactly even though it can be drawn only in side view. The carapace is 3.14 mm. long, 2.35 mm. wide and 0.86 mm. high at the highest point which is situated three quarters of the length of the carapace behind its anterior end. The shape of the carapace may be best understood from figure 150. It slopes forward very gently in an almost straight line, while the posterior declivity is quite steep. Figures 152 and 153 show the cephalothorax in rear view and the posterior edge of the carapace. The eye group is shown in figure 154. It is very troublesome to study on account of the legs partly obstructing the view so that a drawing from above cannot be made. But one can see the left lateral eyes in side view and one can measure individual eyes fairly accurately. The ratio of the eyes is AME : ALE : PLE = 4 : 8 : 5. The anterior median eyes are almost, but not quite in contact and their axes are slightly, but distinctly converging. The anterior lateral eyes are considerably larger, are separated from the anterior median eyes by a little less than the diameter of the latter and are directed almost straight forward. Viewed from in front as in figure 154, the anterior row of eyes is very gently down-curved, and the clypeus under thean terior median eyes is just a little higher than their diameter (5 : 4). The posterior lateral eyes are directed backward, outward and upward and are situated, as the figure shows, on a common tubercle with the anterior lateral eye on each side of the head. The tubercle is as high as the diameter of the anterior lateral eye and its dorsal surface is evenly curved. It has therefore the shape of a cone lying on its side. The surface of the carapace is clothed with very short hair. The chelicerae are evenly attenuated from base to articulation of the fang and are 1.55 mm. long. Their front surface is clothed with slender bristles. The maxillae are long. The lip cannot be seen.

| Legs | Femur | Pat.+Tibia | Metatarsus | Tarsus | Total |
|---|---|---|---|---|---|
| I | 2.71 | — | — | — | — |
| II | 2.71 | 3.29 | — | — | — |
| III | 2.43 | 2.86 | 1.71 | 0.86 | 7.86 |
| IV | 3.14 | 3.43 | 2.00 | 1.00 | 9.57 |
| Palp | 1.10 | 1.05 | 1.00 | | 3.15 |

It is evident from the relative length of the femora that the fourth leg is the longest.

The spines are shorter and stouter than in *S. elongata*. First leg. femur dorsal 1–1–0, tibia prolateral 1–1; second leg, femur dorsal

1–1–0 on left leg, 1–1–2 on right leg, tibia retrolateral 1–1–1; third leg, femur dorsal 1–1–0, tibia prolateral 0–1–1, retrolateral 0–1–1, ventral 0–1p–2, metatarsus ventral 2–0; fourth leg, femur dorsal 1–1–1–1 in proximal half, retrolateral 1 about one fifth from end, tibia ventral 2–2–2–2, metatarsus ventral 2–2, the distal pair very short. No other spines on legs.

The claws are shown in figure 151. They are similar and have seven long teeth. The third claw has a long, single tooth. Serrated bristles and scopulae are wanting. The palpal claw is smooth. The abdomen is 4.14 mm. long to base of spinnerets and 2.57 mm. wide. Its height is only 2.30 mm., which means that it is somewhat flattened below, because its dorsal surface is rounded. The most characteristic feature of the abdomen is the presence of longitudinal wrinkles on the sides, merging with the opposite side wrinkles in the posterior quarter of the abdomen where they are visible on the dorsal surface. Figure 150. The anterior three quarters of the dorsal surface are quite free of wrinkles.

The surface of the abdomen is clothed with very short hair, while the hair on the legs varies in thickness.

On the same slide with the above described spider there is in the amber an exuvium of a much smaller spider with six stout and long ventral spines on the first tibia having apparently the disposition 2–1p–2–1p. On the second tibia there are 2–2–1p ventral spines. The species cannot be identified because important structures are broken off, but the spines remind one of *Eostaianus succini*. If it is so, then it was a very young spiderling. The most interesting feature of the exuvium is the excellent preservation of the pharynx.

*Specimen No. 8500* is only 2.9 mm. long with a carapace 1.15 mm. long. The width of the carapace cannot be measured. The abdomen is clothed with rather coarse, bristly hair which would make one doubt that it belongs to the same species were it not for the plainly visible wrinkles which have the same position and appearance as in the type. The order of the legs is 4123.

| Legs | Femur | Pat.+Tibia | Metatarsus | Tarsus | Total |
|---|---|---|---|---|---|
| I | 1.00 | 1.25 | 0.65 | 0.40 | 3.30 |
| II | 0.85 | 1.00 | 0.65 | 0.35 | 2.85 |
| III | 0.80 | 0.80 | 0.65 | 0.35 | 2.60 |
| IV | 1.15 | 1.35 | 0.85 | 0.40 | 3.75 |

*Specimen No. 7174* is still smaller. It lies with its ventral surface up on a thin sheet of black dirt. The dorsal surface is visible when the slide is turned upside down. Total length 1.75 mm. Carapace

1.10 mm. long, its width cannot be measured. Of the eyes only one pair is visible, presumably the anterior median eyes almost in contact with each other. The surface of the carapace and of the abdomen seem to be glabrous, but the wrinkles on the sides of the latter are plainly visible and cross the dorsal surface in its posterior quarter. The sternum appears to be rather convex, but has the appearance of having been changed in its shape by internal pressure of gas filling the body. The order of the legs is 4123.

| Legs | Femur | Pat.+Tibia | Metatarsus | Tarsus | Total |
|---|---|---|---|---|---|
| I | 0.70 | 0.70 | 0.50 | 0.30 | 2.20 |
| II | 0.65 | 0.70 | 0.50 | 0.30 | 2.15 |
| III | 0.55 | 0.60 | 0.45 | 0.25 | 1.85 |
| IV | 0.75 | 0.85 | 0.85 | 0.30 | 2.75 |

*Specimen No. 9761* I refer to this species with reservation. It is complete and well preserved, but lies on its left side on an uneven sheet of crumpled amber inside of otherwise clear amber. Its ventral surface is partly exposed on the other side of the crumpled sheet, which shows also the spinnerets in side view. The abdomen is clothed with more or less erect, curved, bristly hair. The view of the eyes is badly obstructed by the legs, but all six eyes appear to be of the same size. The clypeus cannot be measured, but seems to be about equal to the diameter of the anterior median eyes. The spinnerets (figure 155) are of somewhat different length and diameter, the posterior pair being more slender and longer. At the end of the posterior spinneret two small spinning tubes and between them a single spigot are visible. The total size of the spider measured in the position in which it lies in the amber is 2.57 mm. and it is therefore certain that it is somewhat greater than the measurement. The carapace cannot be measured. The abdomen is 1.6 mm. long and 0.80 mm. high. Its width cannot be measured. Its sides are with faint indications of longitudinal wrinkles resembling those of the other three specimens. The second and third legs cannot be measured exactly beyond their tibia, because their metatarsus and tarsus are placed at a considerable angle to the surface of the piece and the refraction becomes too great when the specimen is inclined. But it is quite certain that they are not longer, and probably slightly shorter than those of the first leg. It is therefore also certain that the order of legs is 4123.

| Legs | Femur | Pat.+Tibia | Metatarsus | Tarsus | Total |
|---|---|---|---|---|---|
| I | 0.85 | 0.95 | 0.55 | 0.35 | 2.70 |
| II | 0.75 | 0.85 | ? | ? | ? |
| III | 0.67 | 0.67 | ? | ? | ? |
| IV | 0.90 | 0.95 | 0.55 | 0.40 | 2.80 |

The sternum is plainly visible in a three quarter view. Its left edge shows the typical, thorn-like projections for the articulation of the coxae. Its surface is convex and sparsely clothed with curved, bristly hairs. The lip is much longer than wide, with almost parallel sides and lateral basal excavations, just as in *S. elongata*, and the maxillae have the same shape.

## 51 Family DYSDERIDAE

### Genus HARPACTES Templeton 1834

Type *Aranea* hombergi Scopoli

#### HARPACTES EXTINCTUS spec. nov.

Figures 160–167, and 177 and 181

*Type*, No. 8241, immature female.

A single, badly mishandled specimen (figure 181). A piece of the abdominal roof had been polished off and a channel drilled from one side to the abdominal cavity and then left with polishing powder partly filling it. It was necessary for purposes of study to remove this powder and the air as far as that was possible, to cut the surrounding amber sufficiently near to the specimen to permit examination under a 16 mm. apochromat with oculars up to X30. The position of the specimen in the amber is such that many structures can be seen only in certain positions and then only with the aid of special lighting. When the specimen was finally mounted on a slide after completion of the study, many of the details shown in the figures became again invisible. They could be seen, however, if this became absolutely necessary, by removing the specimen, cleaning it of clarite and studying it in mineral oil.

Total length without chelicerae 4.45 mm. Carapace 1.40 mm. long, 0.90 mm. wide, of the shape shown in figure 161. In side-view the carapace appears to be rather low (figure 166) and without any demarcation between the head and the thorax. The eye group (figure 162) is compact and small. It is composed of six eyes, the anterior pair slightly, but distinctly larger than the others, and all six forming a somewhat elongated, transverse ellipse. The clypeus is not greater than the diameter of an anterior eye and possibly not more than its radius but very difficult to see properly and cannot be measured. White emulsion somewhat obstructs the view of the ventral surface, the inner

edge of the maxillae is not clearly outlined and the lip is altogether invisible. With proper illumination one obtains a picture as that shown in figure 167. The sternum is almost triangular and the first coxae are wide apart, while the fourth coxae are subcontiguous. The sternum cannot be measured exactly because of the white emulsion at its edge between the anterior coxae, but it seems to be about as wide as long. Laterally it has only two prolongations on each side (or possibly three, if there is one between the maxillae and the first coxae, a feature which cannot be ascertained in any position of the specimen). The space between the second and third coxae on each side is greater than the space between either the first and second or the third and fourth. The edge of the sternum is clearly visible from its last lateral projection to the posterior end and is quite straight. The chelicerae are much shorter than in species of the genus Dysdera. The left chelicera is shown in its promarginal view in figure 160. There are two minute teeth at the proximal end of the promargin, while the retromargin is with a row of small bristles occupying almost the entire length of the basal segment. The fang is less than half as long as the basal joint and is evenly and rather gently curved. The lateral view of the right maxilla with the palp is shown in figure 165. All legs are well preserved and can be easily measured.

| Legs | Femur | Patella | Tibia | Metatarsus | Tarsus | Total |
|---|---|---|---|---|---|---|
| I | 1.10 | 0.65 | 0.95 | 0.75 | 0.30 | 3.75 |
| II | 1.05 | 0.60 | 0.85 | 0.75 | 0.30 | 3.55 |
| III | 0.90 | 0.40 | 0.60 | 0.75 | 0.30 | 2.95 |
| IV | 1.30 | 0.60 | 1.00 | 0.85 | 0.40 | 4.15 |
| Leg formula | | 4 | 1 | 2 | 3 | |
| | | 2.9 | 2.6 | 2.5 | 2.1 | |

The patella of all legs is rather unusually long and its length is purposely given separately.

The spines are slender, few and difficult to see. There is a dorsal distal spine present on the first and second femur. On the tibiae at least of the third and fourth pair one can see 1–1 prolateral, 1–1 retrolateral and 2–2–2 ventral spines. On the metatarsi the arrangement of spines seems to be the same as on the tibiae. At the end of all tarsi is an onychium with three claws (figure 163). They seem to have the same structure on all legs. The upper claws are strongly curved and have three long teeth. The third claw is also strongly curved, but smooth. Serrated bristles are wanting and the hair is only of the simple type and rather sparse.

The petiolus is plainly visible. The abdomen is ellipsoidal, evenly rounded at both ends, 3.05 mm. long to end of spinnerets, 1.35 mm

wide. Neither the epigynal region, nor the tracheal spiracles can be seen. The question as to whether a colulus is present cannot be answered definitely, but seemingly there is none. The median spinnerets cannot be seen, but the upper and lower spinnerets are plainly visible and the former are longer and more slender than the latter (figure 164). The terminal joint of the upper (posterior) spinnerets is long and much as in Agalenidae but has a single, terminal spinning tube (figure 177). The surface of the abdomen is sparsely clothed with simple, short hair.

If the claws were not plainly visible, one could easily mistake this spider for a Dysdera, but fortunately the majority of the legs are free from emulsion and their position makes the study under high power simple.

Reimoser lists in his Catalogue twenty-seven Recent palaearctic species of Harpactes. A specimen of *H. hombergi* (Scopoli) in my collection has at the end of its posterior spinnerets a single spinning tube, as its fossil relative.

## 52 Family OONOPIDAE

### Genus ORCHESTINA Simon

Type *O. pavesii* Simon

#### ORCHESTINA BALTICA Petrunkevitch, 1942

This tiny spider is represented in the collection of the Museum of Comparative Zoölogy by thirteen specimens. Eight of these are mature males, one a mature female and the remaining four females of indeterminate age. There are nine specimens in the British Museum. They were described by me in detail and there seems to be nothing new to be added here. The species was undoubtedly quite common and its jumping habits made entanglement in resin simple. In the present palaearctic fauna the genus Orchestina is represented by a single species, the genotype, found in Southern France, Corsica, Spain, Algier and Arabia. Four species occur in North America.

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PLATES

PLATE 1

## PLATE 1

Fig. 1. Dorsal view of *Paruroctea blauvelti* Petrunkevitch, specimen No. 7127, X 55. Of the inner organs the heart and the ovary are shown, the chylenteron is purposely omitted to avoid confusion. It will be noticed that the visceral mass, the limits of which are shown in outline by the continuous black line, shrank in fossilization and became displaced from its normal position. The hairs on the dorsal abdominal wall are also purposely omitted so as not to obstruct the view of the heart and ovary.

Fig. 2. The sterno-coxal region of the same specimen, X 55.

Fig. 3. Retrolateral view of the claws of the third left leg, X 275.

Fig. 4. *Archaea hyperoptica* Menge. Hypotype, No. 7127 *b*. Lateral view of right palp showing the row of sense organs, X 275.

Fig. 5. Dorsal view of the same specimen, with legs omitted, X 17.

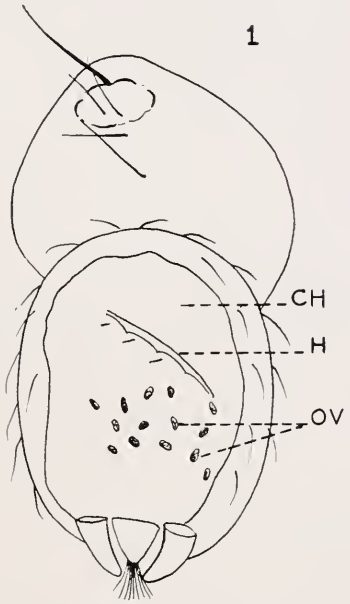
Fig. 6. Onychium and one upper claw of the third right leg, X 275. The other claws are not shown.

Fig. 7. Sterno-coxal region of the same specimen, X 50.

Fig. 8. The specimen as it appears in side view, but with the left legs omitted from the drawing, X 17. The dotted outline of the first leg represents the missing portion drawn to correct size from its mate which is complete.

Fig. 9. Front view of the face, X 32.

Fig. 10. Palp, maxilla and lip in side view, X 32.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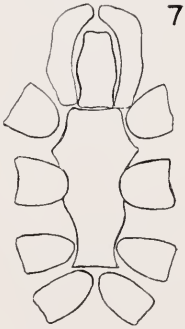
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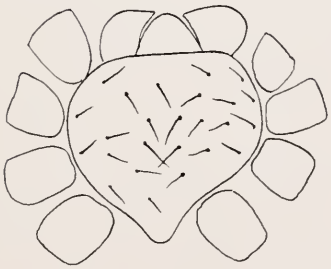
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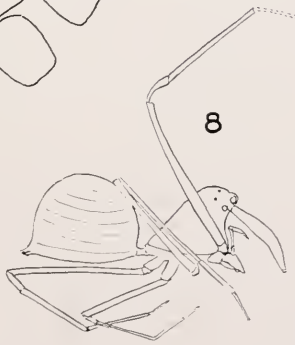
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PLATE 2

## PLATE 2

Fig. 11. Lateral view of *Eolathys succini* spec. nov., No. 7453, X 15. Type.

Fig. 12. Cribellum (CR), median and anterior (lateral) spinnerets, X 32. The posterior spinnerets are omitted from the drawing.

Fig. 13. Upper proclaw and third claw of the fourth right leg, X 275.

Fig. 14. Sternum, X 15.

Fig. 15. The eye group viewed from above, X 100.

Fig. 16. Fourth right metatarsus with calamistrum, X 32.

Fig. 17. Spinnerets viewed from the right side, X 32. In front of the anterior spinnerets the cribellum is visible and above the posterior spinnerets the anal tubercle is shown.

Fig. 18. Carapace viewed from above, X 32.

Fig. 19. Chelicerae and anterior eyes of *Eolathys debilis* spec. nov., No. 7641 *b*, type, viewed from in front, X 62.

Fig. 20. Eye group viewed from above, X 100. This drawing is not a camera lucida drawing, but the result of a study of the eye group from different angles of view by tipping the specimen to make individual eyes visible.

Fig. 21. Epigynum, X 100.

Fig. 22. Upper proclaw and third claw of fourth leg, X 250.

Fig. 23. Fourth right metatarsus with calamistrum, X 32.

Fig. 24. Sterno-coxal region, X 32.

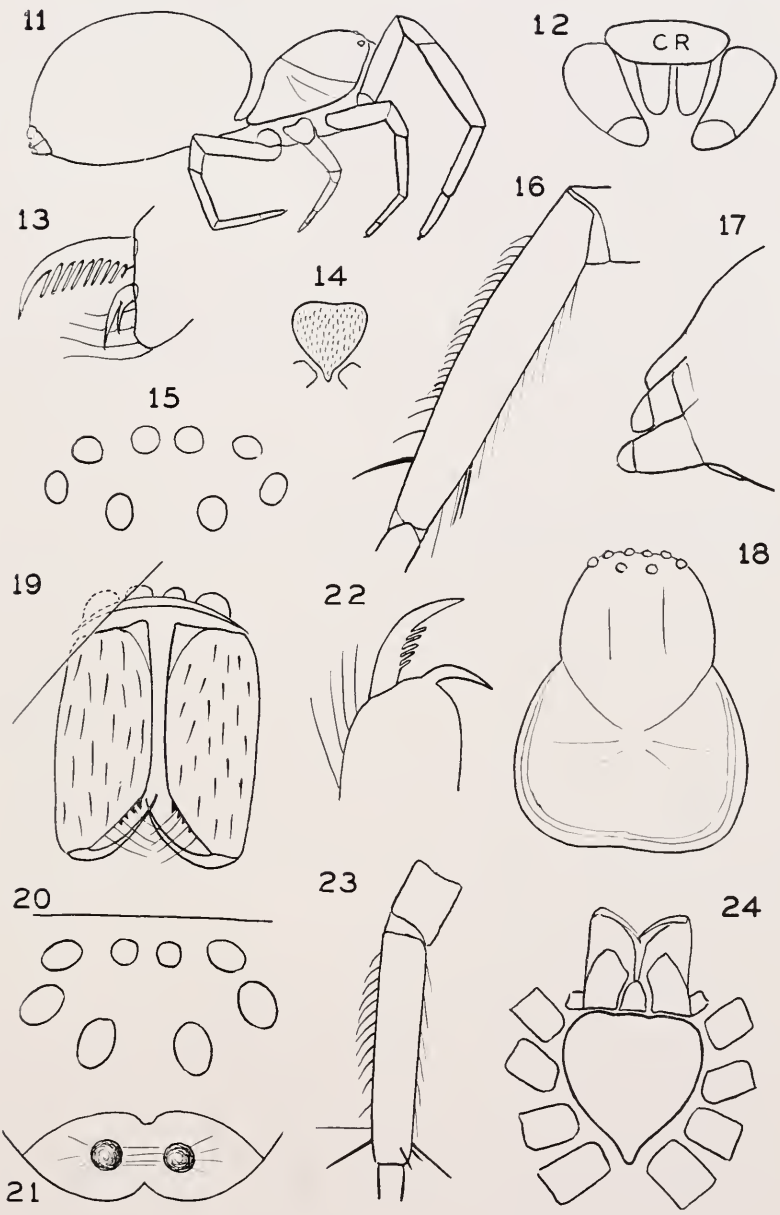
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PLATE 3

## PLATE 3

Fig. 25. *Auximus fossilis* spec. nov., type, No. 7030, viewed from above, X 9.5.

Fig. 26. Fourth right metatarsus of the same specimen, showing the calamistrum and the spines, X 55.

Fig. 27. Eye group of the same specimen, viewed from above, X 55.

Fig. 28. Proclaw and third claw of first left leg, X 250.

Fig. 29. *Myro hirsutus*, specimen No. 7181, sterno-coxal region, X 32.

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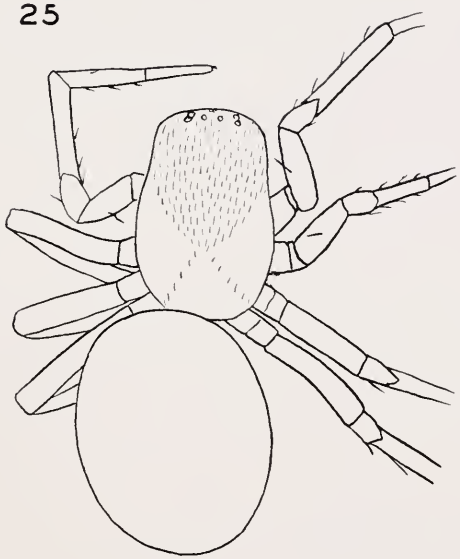

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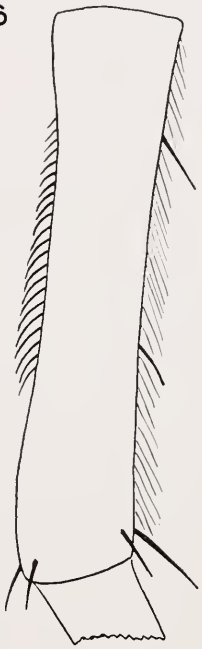

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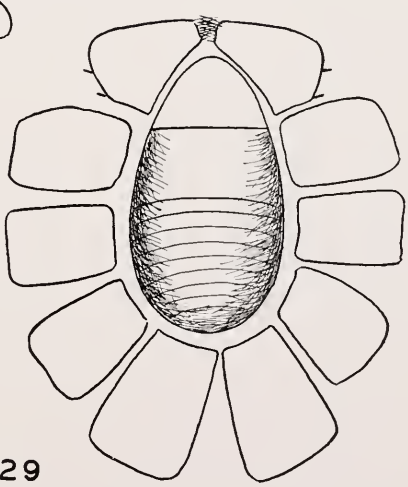

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PLATE 4

## PLATE 4

Fig. 30. *Myro hirsutus* Petrunkevitch, specimen No. 7181. View from above of the anterior end of the carapace with chelicerae, X 32.

Fig. 31. Face view of the same specimen, X 32.

Fig. 32. Eye group viewed from above, X 100.

Fig. 33. Spinnerets and anal tubercle (AT), X 50. The median spinnerets are not visible.

Fig. 34. Prolateral view of left palp, X 50.

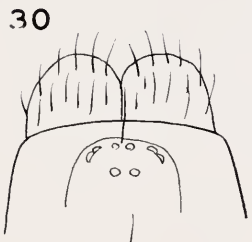
Fig. 35. Dorsal view of left palp, X 50.

Fig. 36. Upper proclaw and third claw of first leg, X 250.

Fig. 37. Upper proclaw with the retroclaw behind it, second leg, X 250. The third claw is not visible.

Fig. 38. Upper proclaw and third claw and below them the retroclaw of the third leg, X 250. The retroclaw is shown separately, so as not to obstruct the view of the other claws.

Fig. 39. Upper proclaw and third claw of the fourth leg, X 250.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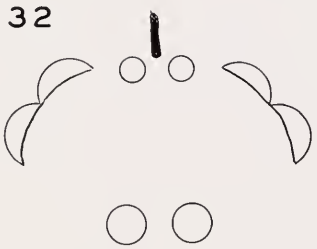
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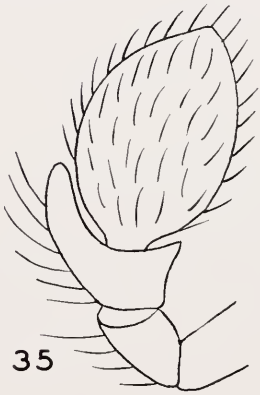
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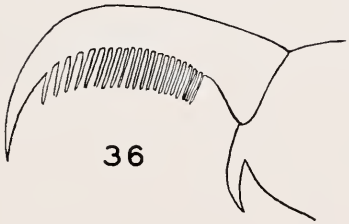
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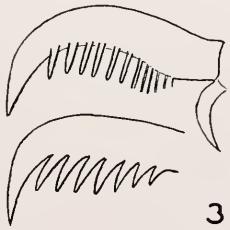
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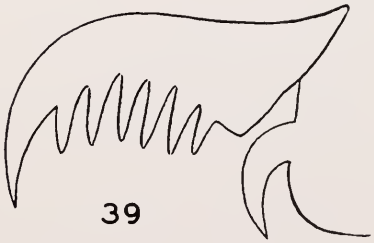
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PLATE 5

## PLATE 5

Fig. 40. Dorsal view of *Eocryphoeca distincta*, type, drawn with the aid of a camera lucida, but the legs arranged in conventional manner, with their length properly related to the length of the carapace by actual measurement, X 9.

Fig. 41. Eye group viewed from above, X 62.

Fig. 42. The group of six spinnerets viewed from below, X 50.

Fig. 43. Upper retroclaw and third claw of first right leg, X 275.

Fig. 44. Trichobothria on first right metatarsus and tarsus, X 35.

Fig. 45. Second right metatarsus showing the three pairs of ventral spines, X 50.

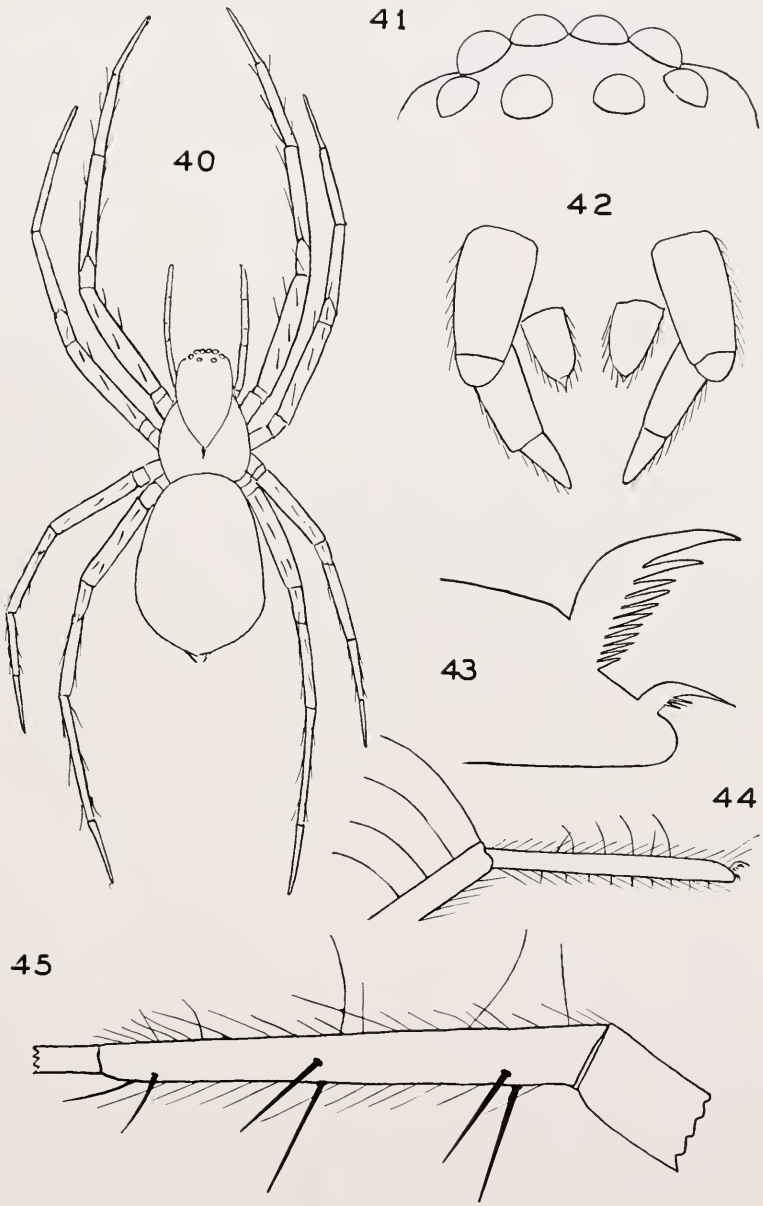
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PLATE 6

## PLATE 6

Fig. 46. Terminal joint of posterior spinneret of *Eocryphoeca distincta*, type, No. 7751, showing the spinning tubes, X 200.

Fig. 47. Spinning tubes of the median spinneret, X 200.

Fig. 48. Terminal joint of anterior spinneret with the spinning tubes, X 200.

Fig. 49. Rhomboid pre-epigynal swelling, X 32.

Fig. 50. *Linyphia oblonga* K. and B., No. 8519. Anterior end of carapace with the eye group viewed from in front, X 62.

Fig. 51. *Nactodipoena infulata* (K. and B.), hypotype, No. 9191, in side view with legs omitted, X 25.

Fig. 52. Metatarsus and tarsus of the first leg, X 100.

Fig. 53. Carapace viewed from above, X 50.

Fig. 54. Dorsal view of eye group, X 100.

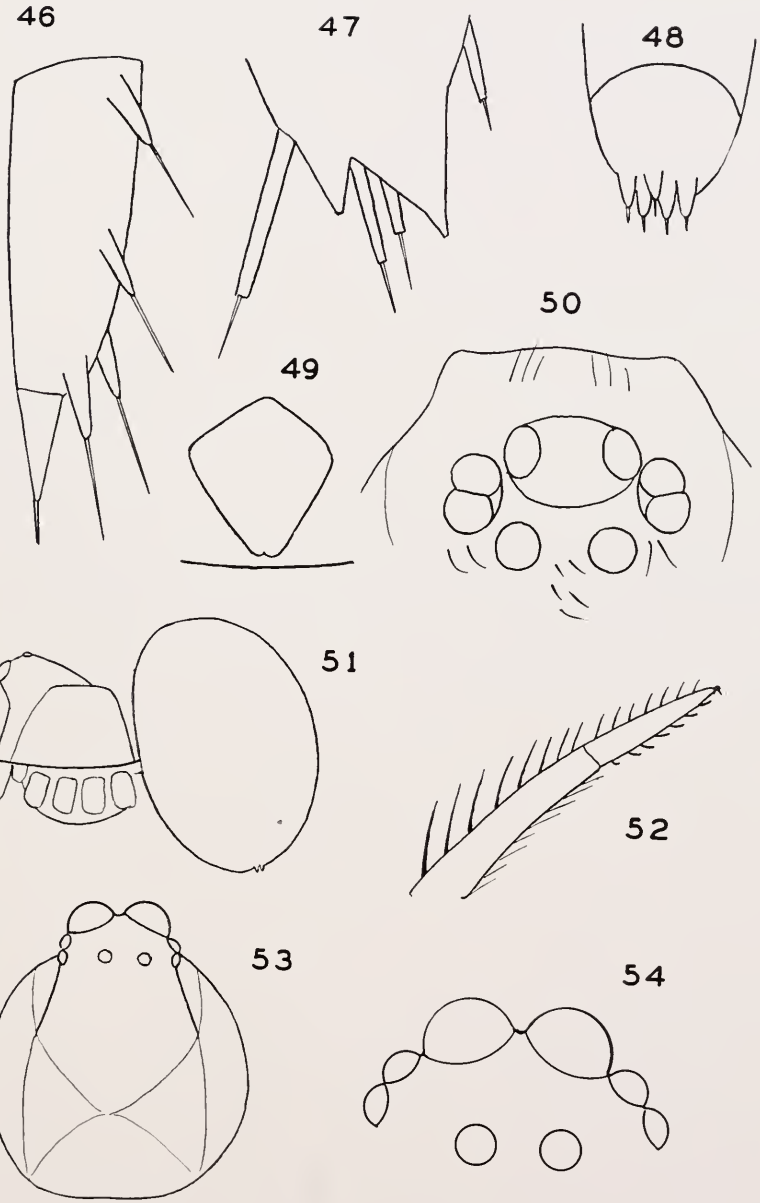
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PLATE 7

## PLATE 7

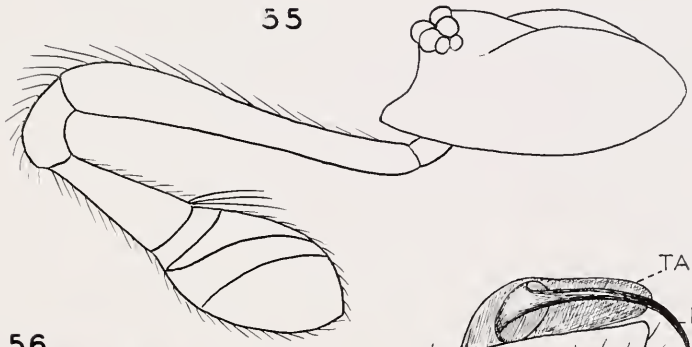
Fig. 55. Side view of carapace and left palp of male *Flegia longimana* Koch and Berendt, No. 7225, X 32. The relative length of the palp and carapace is characteristic of the species.

Fig. 56. Left palp of *Eustaloides succini* Petrunkevitch, No. 8219, X 62. EM — embolus, HA — hematodocha, LA — lateral angle of the tibia, PC — paracymbium, TA — terminal apophysis, TG — tegulum.

Fig. 57. Same palp turned 90°, X 62. Lettering same as in Fig. 56.

Fig. 58. Maxillae, lip and anterior edge of sternum, X 32.

Fig. 59. Eye group viewed from above, X 62.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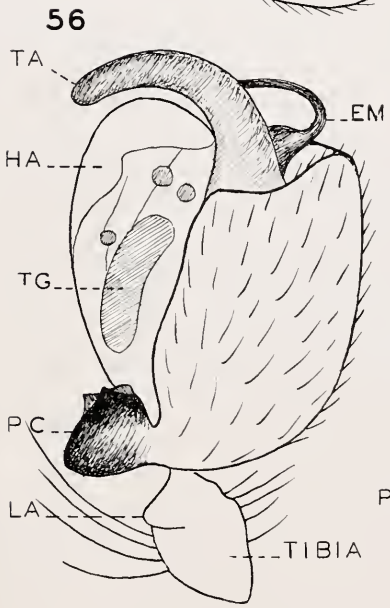
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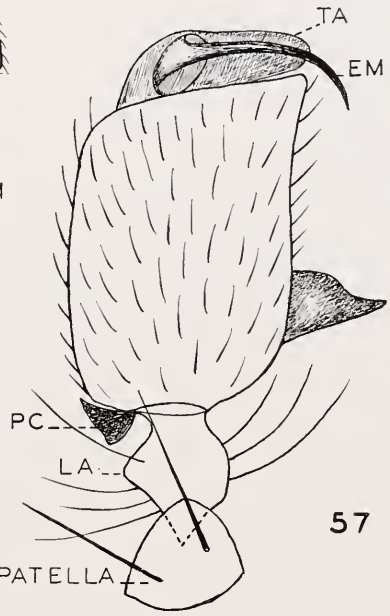
TA
EM
HA
TG
PC
LA
TIBIA


TA
EM
PC
LA
PATELLA
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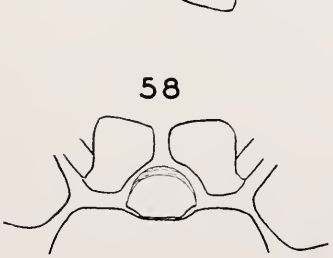
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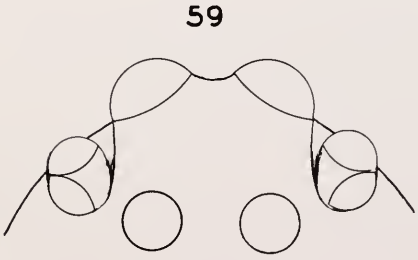
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PLATE 8

## PLATE 8

Fig. 60. Upper proclaw and third claw of first leg of *Eustaloides succini* Petrunkevitch, No. 8219, X 275.

Fig. 61. Upper retroclaw of the first leg of the same specimen, X 275.

Fig. 62. Upper proclaw and third claw of the second leg of the same specimen, X 275.

Fig. 63. First right leg of the same specimen, X 15. Only spines visible in retro-lateral view are shown.

Fig. 64. Third right leg of the same specimen, X 15. Only spines visible in retro-lateral view are shown.

Fig. 65. Dorsal view of the same specimen, corrected for symmetry and with legs omitted, X 15.

Fig. 66. Palpal claw of *Eustaloides minor* spec. nov., type, No. 7137, X 275.

Fig. 67. Carapace of the same specimen viewed from above, X 15.

Fig. 68. Epigynum of the same specimen in side view, X 62.

Fig. 69. Same epigynum viewed from below, X 62.

Fig. 70. Eye group viewed from in front, X 62.

Fig. 71. Same eye group viewed from above, X 50.

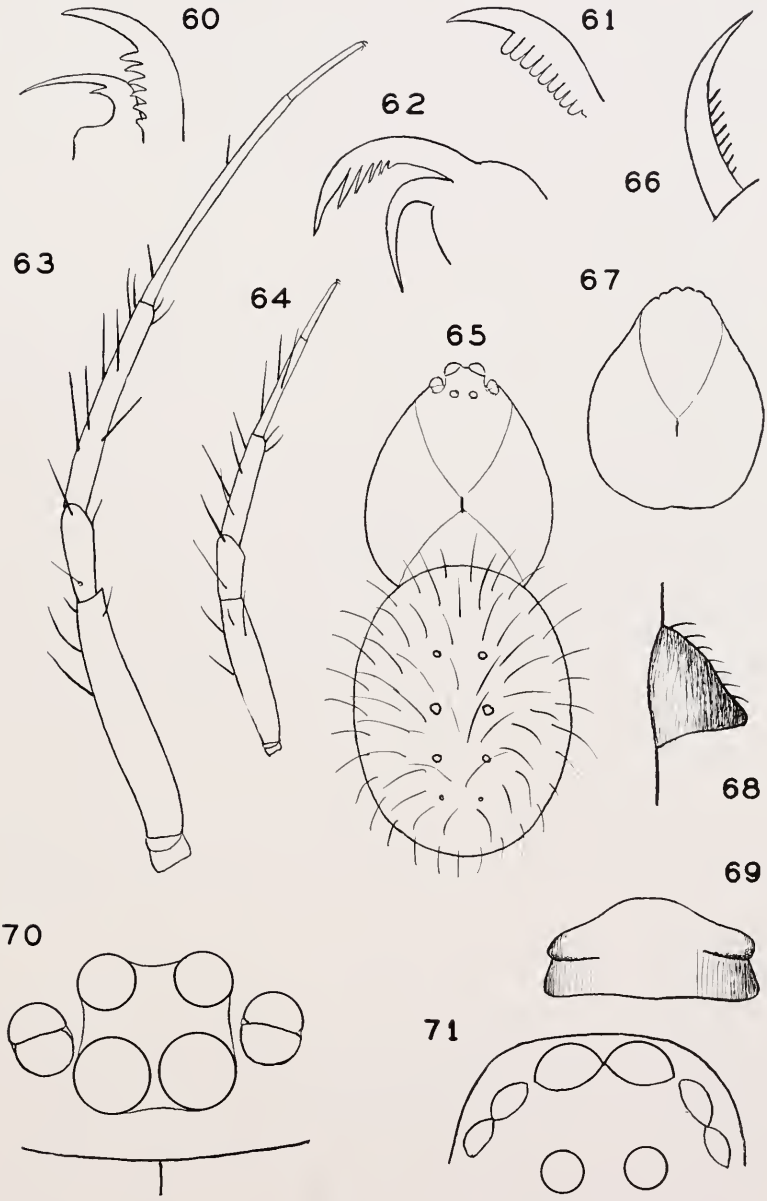
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PLATE 9

## PLATE 9

Fig. 72. Side view of carapace of *Eustaloides minor* spec. nov., type, No. 7137, X 15.

Fig. 73. The spinnerets of the same specimen, X 55. SP — tracheal spiracle.

Fig. 74. Sterno-coxal region of the same specimen, X 62.

Fig. 75. Sterno-coxal region of *Eustaloides calceatus* spec. nov., type, No. 7444, X 25.

Fig. 76. Eye group of type, viewed from above, X 62.

Fig. 77. Right palp of specimen No. 7444, viewed from below, X 32. EMB — embolus, TA — terminal apophysis.

Fig. 78. Left palp of No. 6368, X 32. PC — Paracymbium, pro-lateral view.

Fig. 79. Right palp of specimen No. 6368 in retrolateral view, X 32. EMB — embolus, PC — Paracymbium.

Fig. 80. Left palp of *Eustaloides setosus* Petrunkevitch, No. 7445, in pro-lateral view, X 32. The hematodocha of this palp was evidently fully extended exposing to view the median subterminal apophysis (MST) and the lateral subterminal apophysis shown in black immediately under the former. The edge of the right palp shown as a curved line hides from view the rest of the left palp. TA — terminal apophysis.

Fig. 81. Right palp of the same specimen in retrolateral view, X 32. TA — terminal apophysis.

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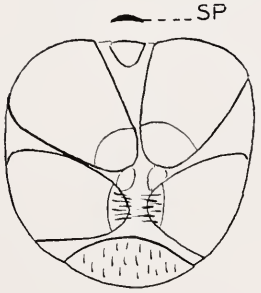
SP
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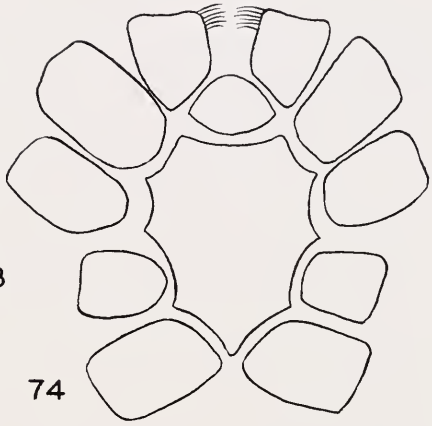
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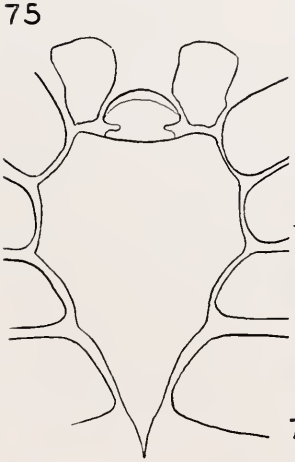
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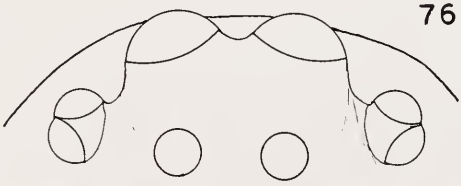
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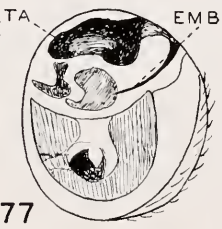
TA
EMB
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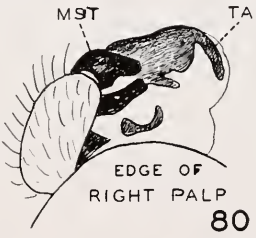
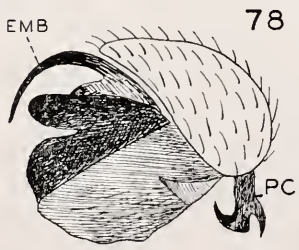

MST
TA
EDGE OF
RIGHT PALP
80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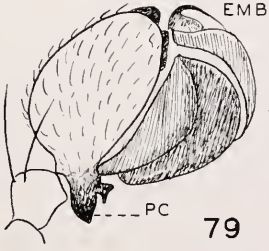
EMB
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PLATE 10

## PLATE 10

Fig. 82. Right palp of *Eustaloides setosus* Petrunkevitch, No. 7445, viewed from above, X 32.

Fig. 83. Left palp of *Elucus infelix* spec. nov., type, in retrolateral view, No. 7002, X 175. EM — embolus, C — conductor, RS — sperm receptacle, TR — trichobothria.

Fig. 84. Dorsal view of carapace of the same specimen, X 32.

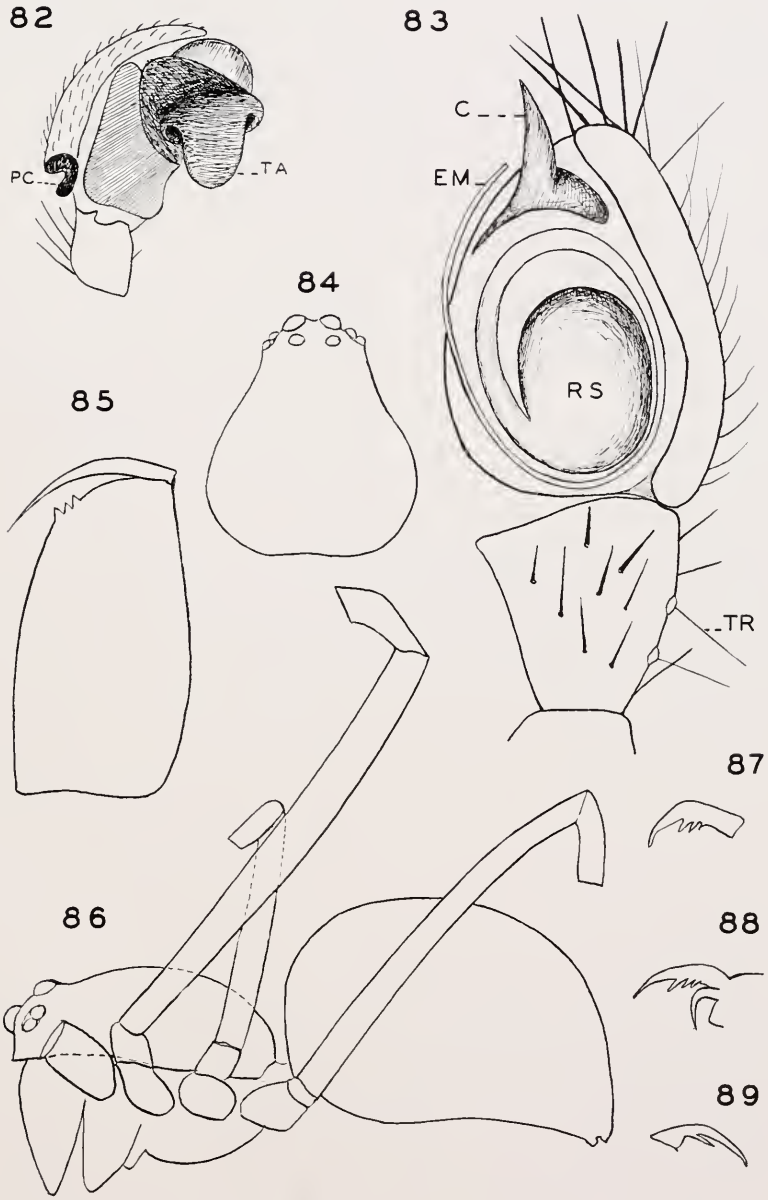
Fig. 85. Right chelicera X 100.

Fig. 86. Side view of spider X 32. The legs are not shown, although all eight legs are present. They may be seen in the photograph.

Fig. 87. Retroclaw of first right leg X 275.

Fig. 88. Retroclaw and third claw of second right leg X 275.

Fig. 89. Retroclaw of third left leg X 275.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PC
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C
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RS
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PLATE 11

## PLATE 11

Fig. 90. Dorsal view of *Ephalmator fossilis* spec. nov., type, No. 7882, X 25. The legs are not shown.

Fig. 91. Dorso-prolateral view of left palp X 62.

Fig. 92. Right palp of same specimen viewed from above X 62.

Fig. 93. Eye group viewed from above X 100.

Fig. 94. Side view of type X 25.

Fig. 95. Sterno-coxal region X 25.

Fig. 96. Spinnerets X 50.

Fig. 97. Spinning tubes at the end of the right anterior spinneret, X 200. One spigot and 13 small tubes are present.

Fig. 98. Spinning tubes at the end of the left posterior spinneret, X 200. One spigot and 11 small tubes are present.

Fig. 99. Spinnerets and silk threads with viscid drops, of the paratype, No. 7188, X 55.

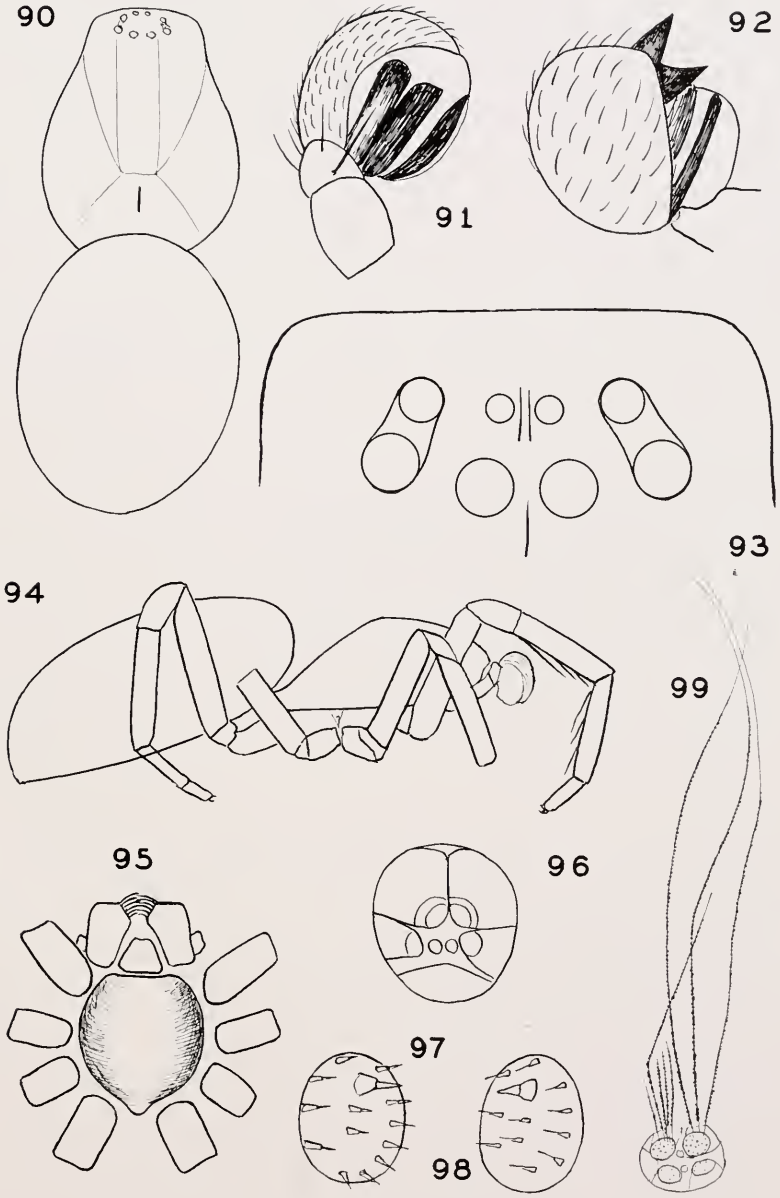
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PLATE 12

## PLATE 12

Fig. 100. Prolateral view of first tibia of *Ephalmator fossilis* paratype, No. 7188, X 50. Only the proventral spines are shown.

Fig. 101. Retrolateral view of the second left leg of the same specimen X 50. Only the retroventral spines are shown.

Fig. 102. Left chelicera of *Ephalmator fossilis* type, No. 7882, in prolateral view, X 50.

Fig. 103. Claws of first right leg of *Ephalmator fossilis* type, No. 7882, in prolateral view, X 200.

Fig. 104. Silk threads with adhesive droplets of *Ephalmator fossilis* paratype, No. 7188, X 250.

Fig. 105. Upper proclaw of fourth left leg of *Ephalmator fossilis* type, No. 7882, X 200.

Fig. 106. Second left leg of the type specimen No. 7882 in retrolateral view X 50, showing only the retroventral spines.

Fig. 107. First right leg of the type in prolateral view X 50, showing only the proventral spines.

Fig. 108. First left leg of the type in retrolateral view X 50, showing only the retroventral spines.

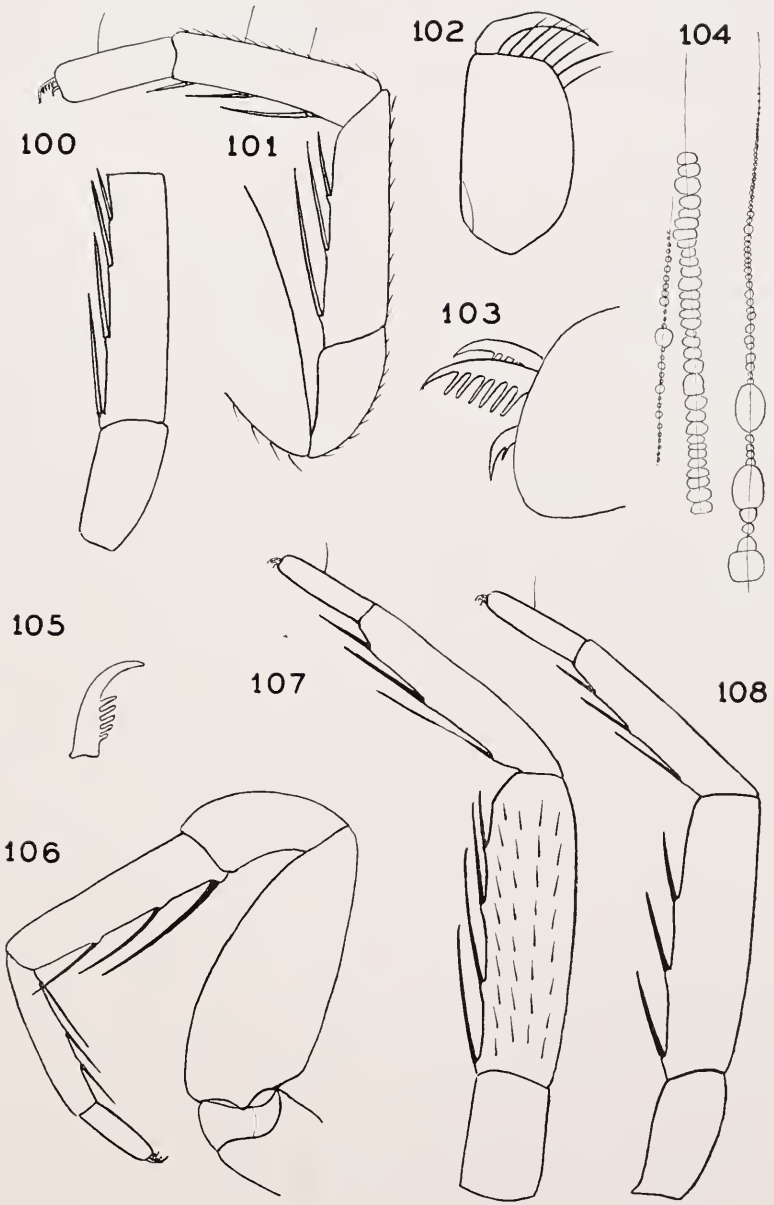
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PLATE 13

## PLATE 13

*Zachria desiderabilis* spec. nov., type, No. 7139

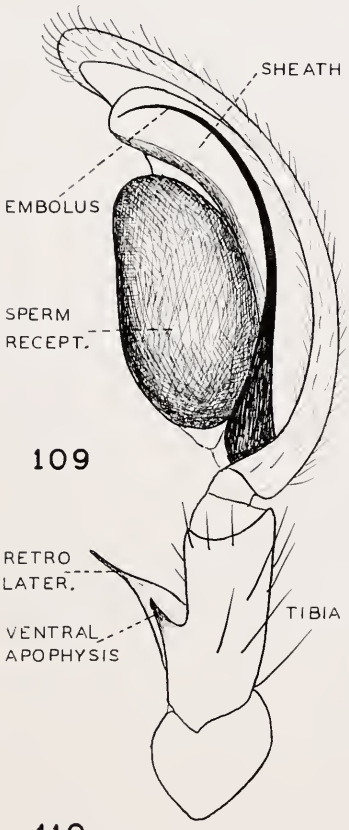
Fig. 109. Prolateral view of the right palp X 32.

Fig. 110. Tibia of the left palp in a retrolateral view X 32.

Fig. 111. Carapace viewed from above X 15. The missing portion is shown in outline.

Fig. 112. The right fourth tarsus X 32 showing the scopula along its ventral surface and the row of trichobothria in the dorsal median line.

Fig. 113. View of the first row of eyes, clypeus and chelicerae from in front X 32.

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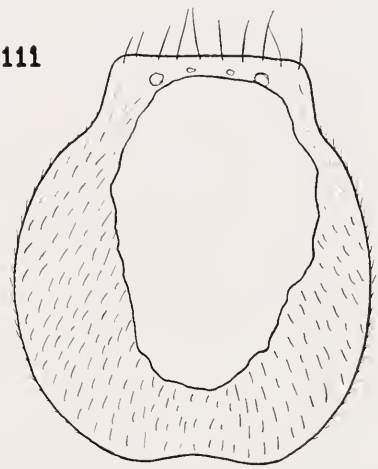

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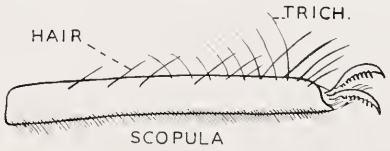


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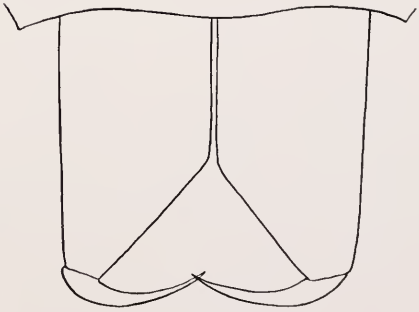

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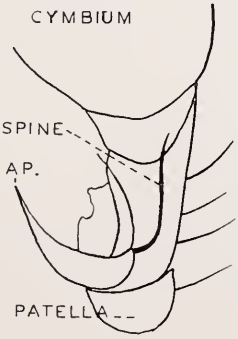


PLATE 14

## PLATE 14

Fig. 114. Proclaw of fourth right tarsus of *Zachria desiderabilis* type, No. 7139, X 200.

Fig. 115. Dorsal view of the femur and patella of the left palp of *Z. desiderabilis* type. X 32.

Fig. 116. Portion of the fourth left leg of the same specimen viewed from above X 15. The femur presents its dorsal, the tibia its ventral surface.

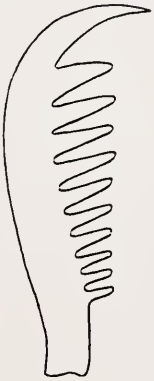
Fig. 117. Sterno-coxal region of the same specimen X 15.

Fig. 118. Spinnerets X 55. AT — anal tubercle. The median spinnerets are not visible.

Fig. 119. Dorsal view of eye group of *Eostaianus succini* spec. nov., type, No. 7997*a*, X 88.

Fig. 120. Claws of second right leg of *E. succini* type, X 275.

114



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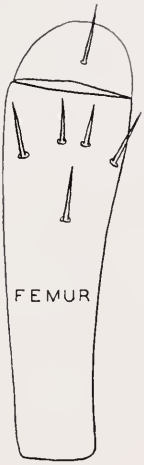


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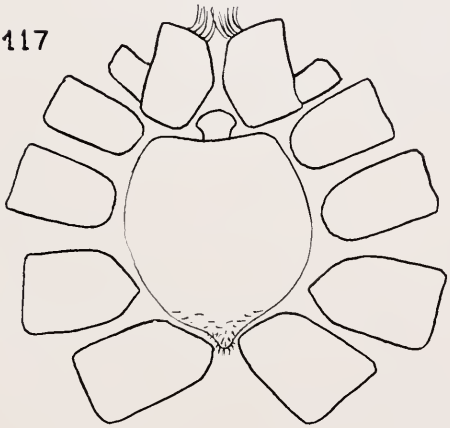

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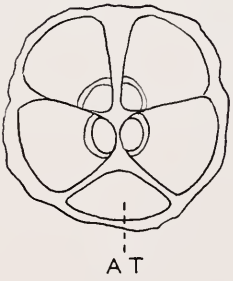


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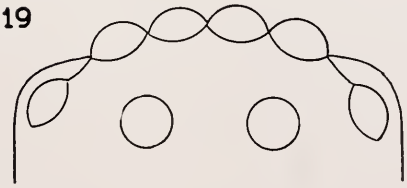

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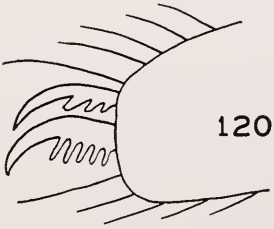

PLATE 15

## PLATE 15

Fig. 121. Dorsal view of *Eostaianus succini* spec. nov., type, No. 7997a, X 15. The legs are not shown.

Fig. 122. Sterno-coxal region of type X 32.

Fig. 123. First row of eyes and chelicerae of type in face view X 32.

Fig. 124. First left leg of type X 22, from above, showing the proventral spines.

Fig. 125. Dorsal view of *Caduceator quadrimaculatus* spec. nov., type, No. 7221. X 11. The legs are represented in their normal position. In the specimen they are so flexed that they appear on the underside of the spider, as may be seen in the photograph. The white portions of the carapace and abdomen are clothed with white hair, the dark portions with dark hair.

Fig. 126. Eye group of *C. quadrimaculatus* type, viewed from above, X 62.

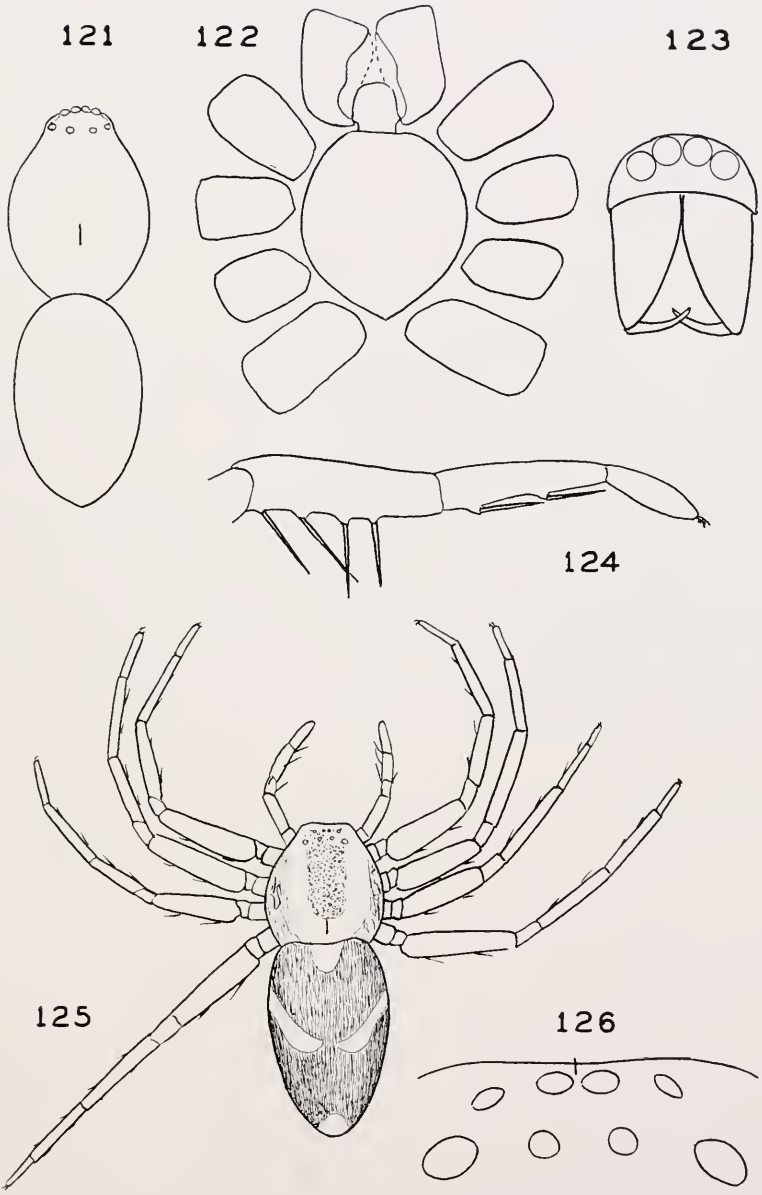
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PLATE 16

## PLATE 16

Fig. 127. Ventral surface of *Caduceator quadrimaculatus* spec. nov., type, No. 7221, X 32. Behind the epigynum with its pair of receptacles several transverse corrugation lines of the ventral abdominal wall are shown.

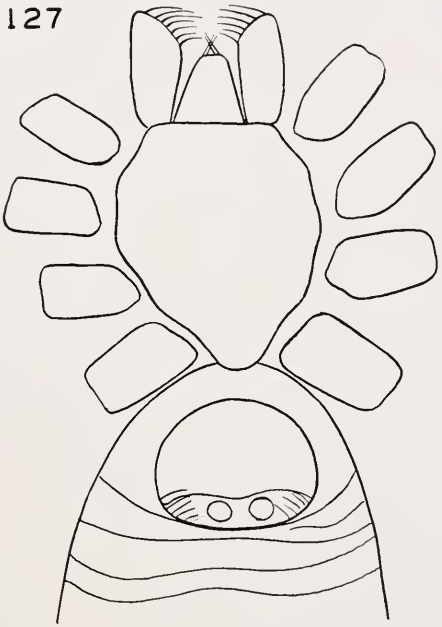
Fig. 128. End of first left tarsus of *Syphax asper* spec. nov., type, No. 7661, showing the proclaw and the claw tufts. X 275.

Fig. 129. Maxillae, lip and anterior end of sternum of *S. asper* X 50.

Fig. 130. Lanceolate and simple hair on the dorsal abdominal wall of *Syphax asper*, type. The drawing shows also the lines on the surface of the chitin. X 275.

Fig. 131. Dorsal view of *Eothanatus diritatis* spec. nov., type, No. 7441, X 15. The legs are omitted from the drawing.

127



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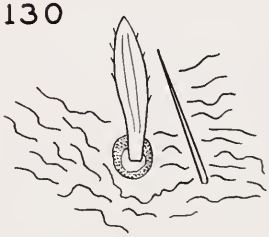

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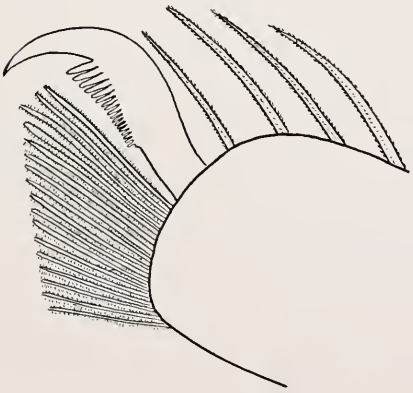

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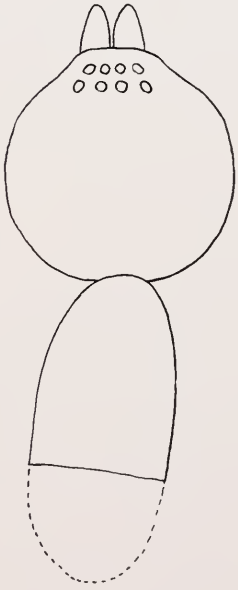

PLATE 17

## PLATE 17

Fig. 132. Face view of *Eothanatus diritatis* spec. nov., type, No. 7441, X 32.

Fig. 133. Prolateral view of the left palp of the same specimen X 32.

Fig. 134. Dorsal view of the right palp showing the retrolateral tibial apophysis X 32. Same specimen.

Fig. 135. Sterno-coxal region of the same specimen X 32.

Fig. 136. A group of dorsal abdominal hairs of the same specimen, X 250.

Fig. 137. Claws and claw tufts of second left tarsus of the same specimen, X 250.

Fig. 138. Dorsal view of eye group of *Fiducia tenuipes* spec. nov., type, No. 7751, X 125.

Fig. 139. Sterno-coxal region of *F. tenuipes* paratype, No. 7432, X 32.

Fig. 140. Basal joint of right chelicera of *F. tenuipes* paratype, No. 7192, X 100, showing the promarginal teeth.

Fig. 141. A claw of the first left leg of *F. tenuipes* type, No. 7751, X 275.

Fig. 142. Claws and claw tufts of fourth left tarsus of *Abliguritor plumosus* spec. nov., type, No. 7624, X 275.

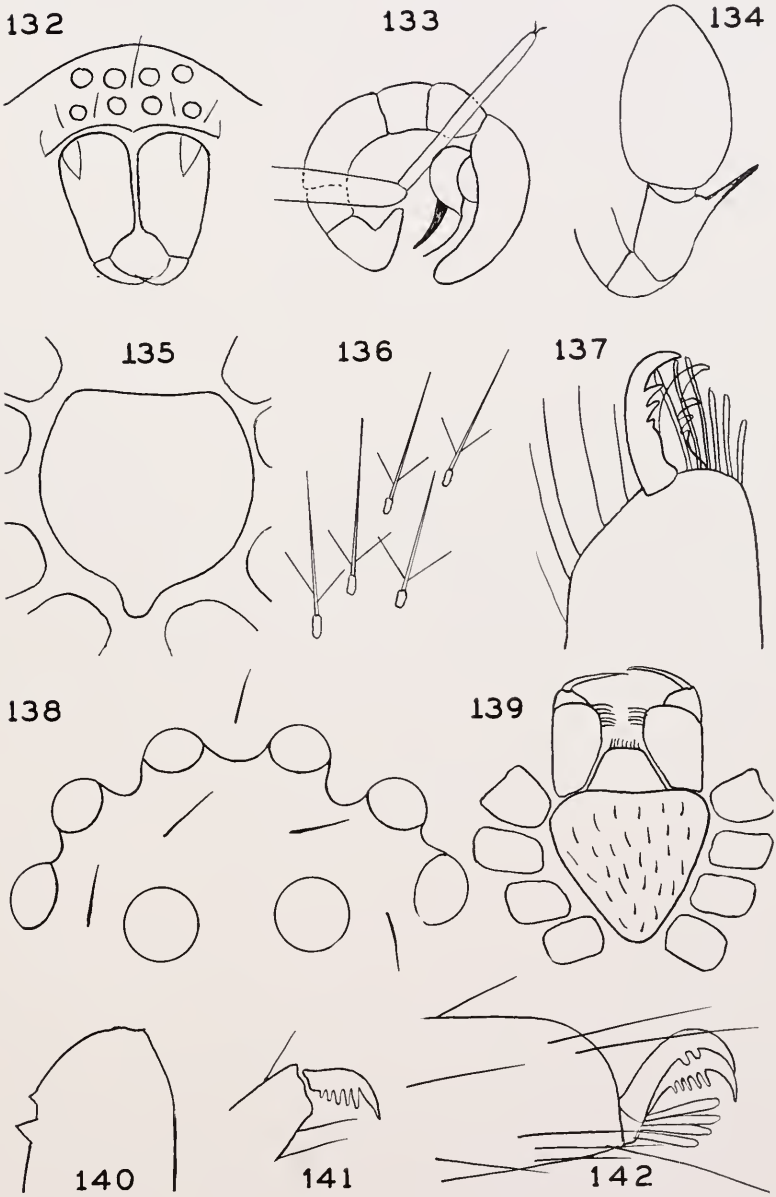
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PLATE 18

## PLATE 18

Fig. 143. First right tibia of *Abliguritor plumosus* spec. nov., type, No. 7624, X75. Only the four proventral spines are shown.

Fig. 144. First right metatarsus of the same specimen X 75. Only the proventral spine is shown.

Fig. 145. Second left tibia of the same specimen X 75. Only the proventral spines are shown.

Fig. 146. Second left metatarsus of the same specimen X 75. Only the proventral spine is shown.

Fig. 147. Lanceolate plumose hairs of the same specimen X 275.

Fig. 148. Dorsal view of carapace and portion of the abdomen of the same specimen X 32.

Fig. 149. Prolateral view of right palp of *Gorgopis frenata* (Koch and Berendt) No. 7269, X 55.

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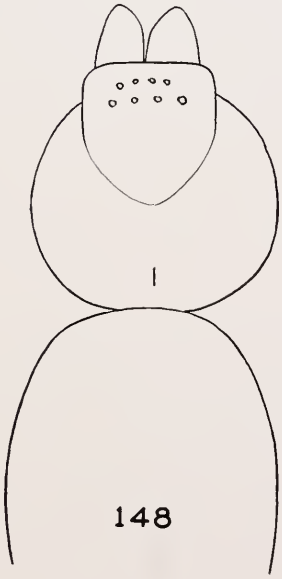
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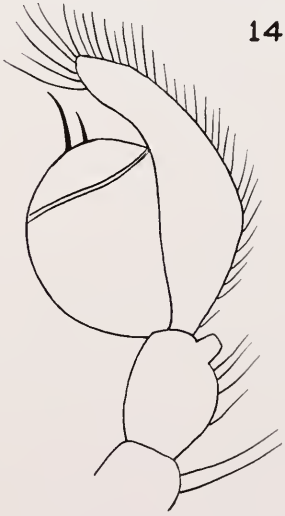
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## PLATE 19

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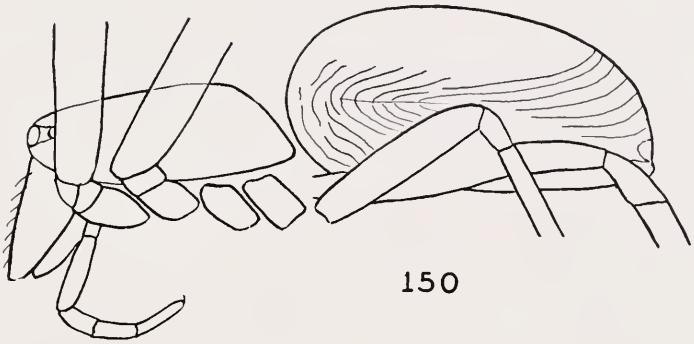

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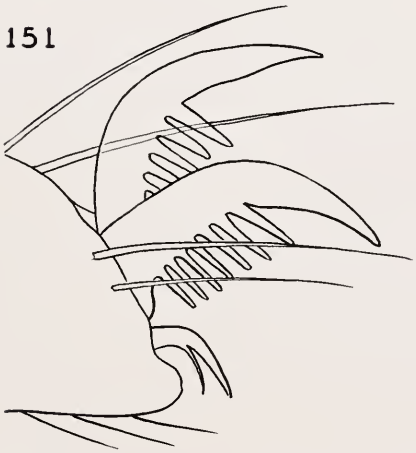

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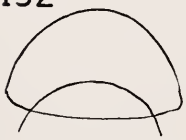

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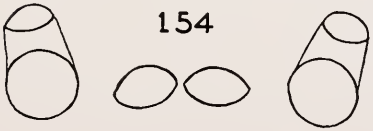

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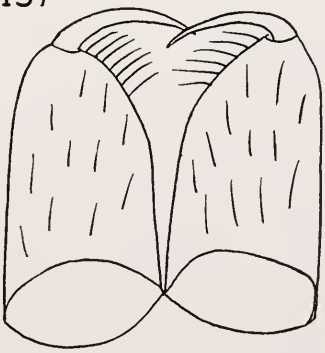

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## PLATE 20

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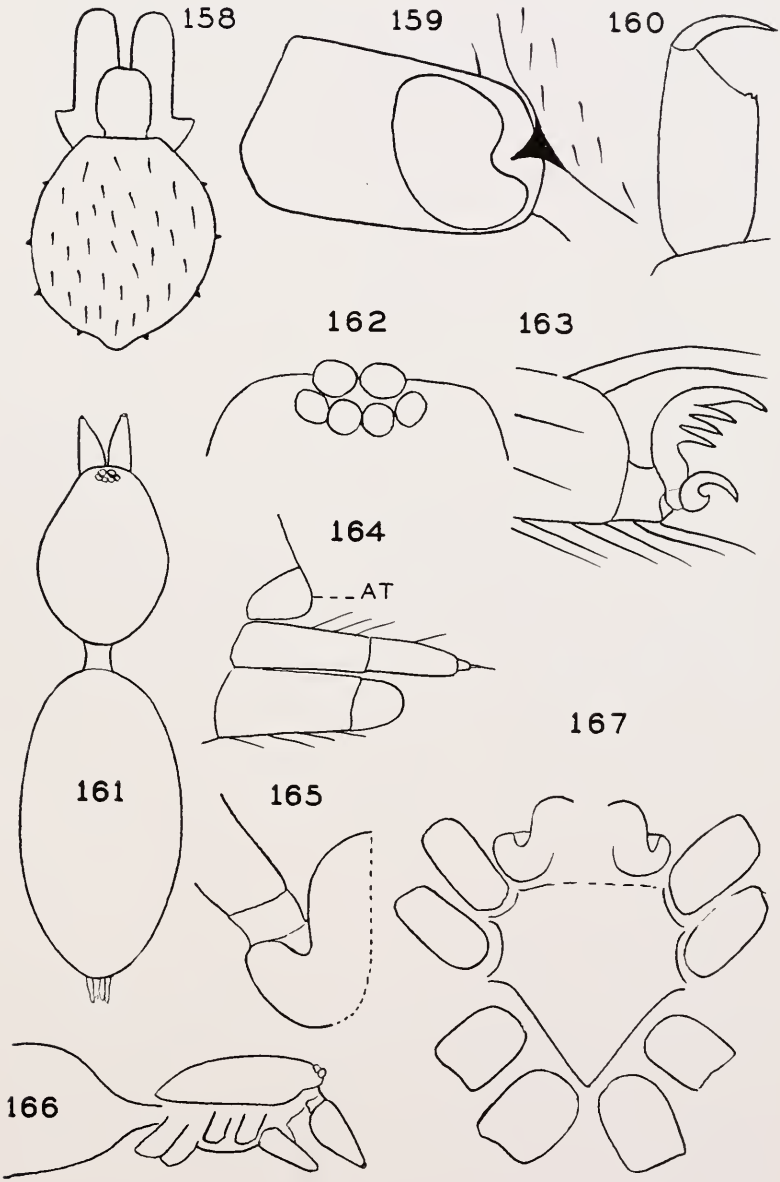
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PLATE 21

## PLATE 21

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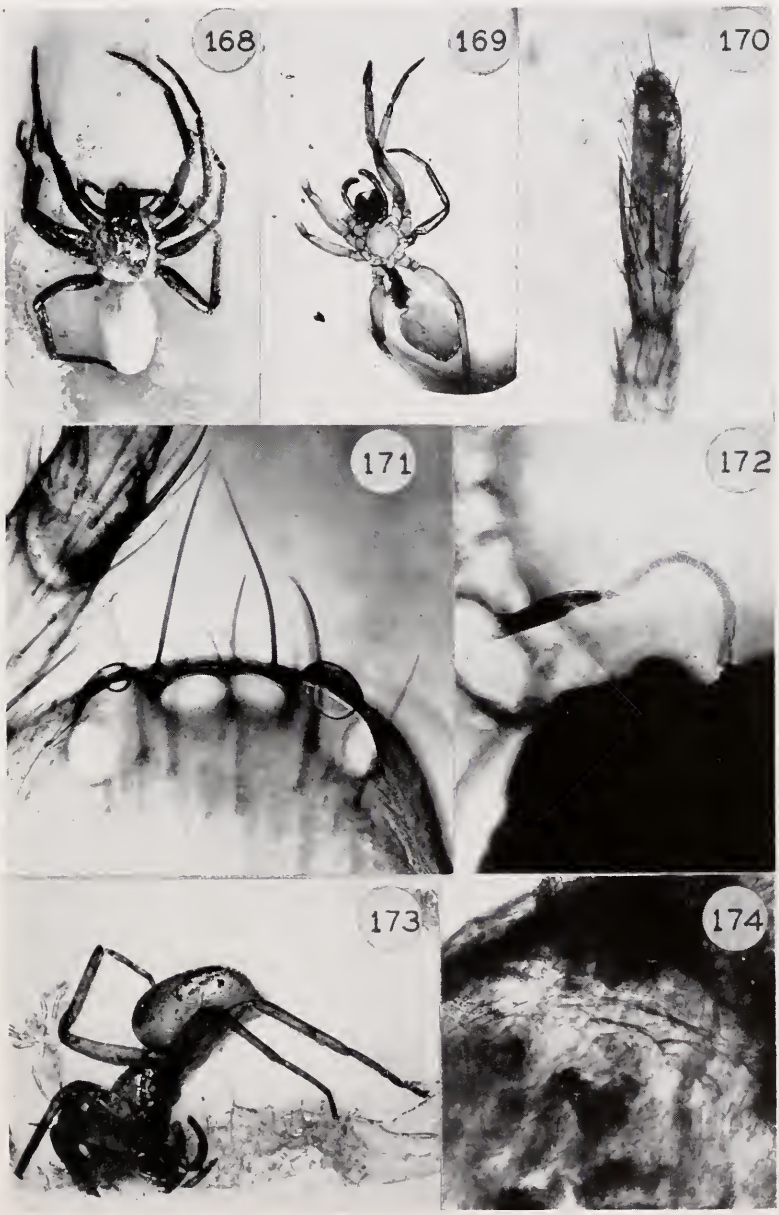
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PLATE 22

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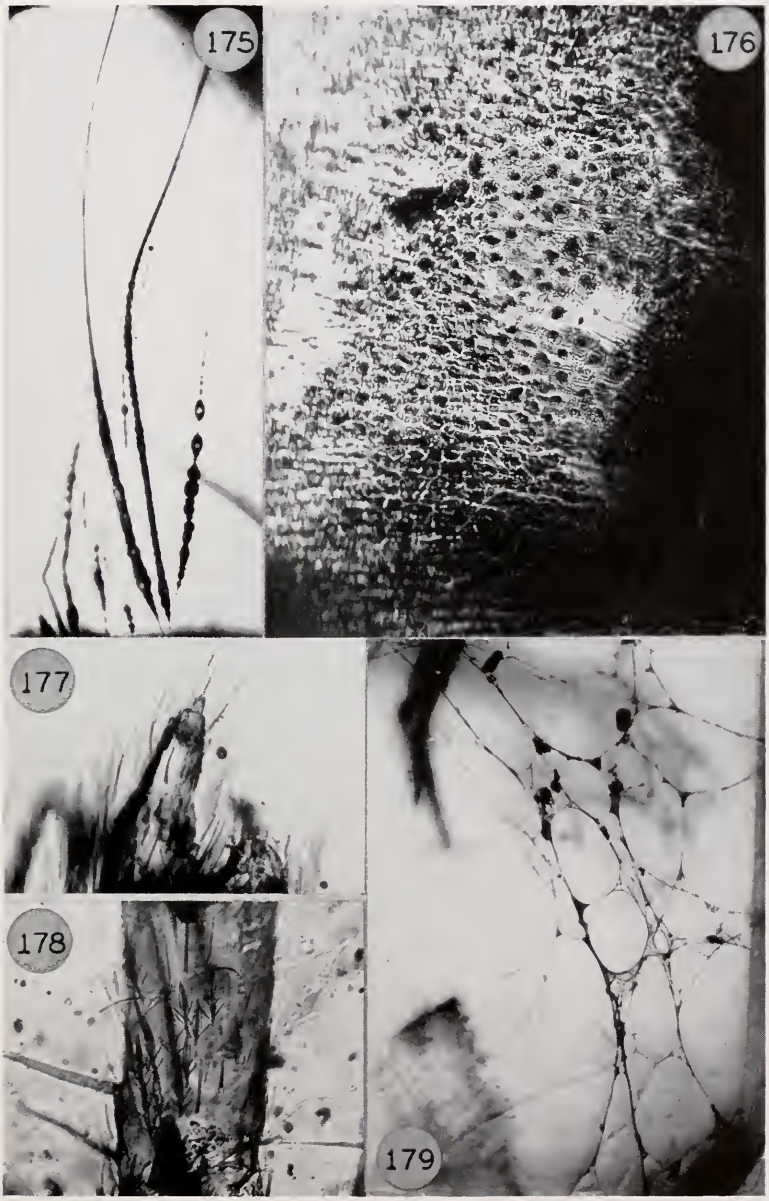
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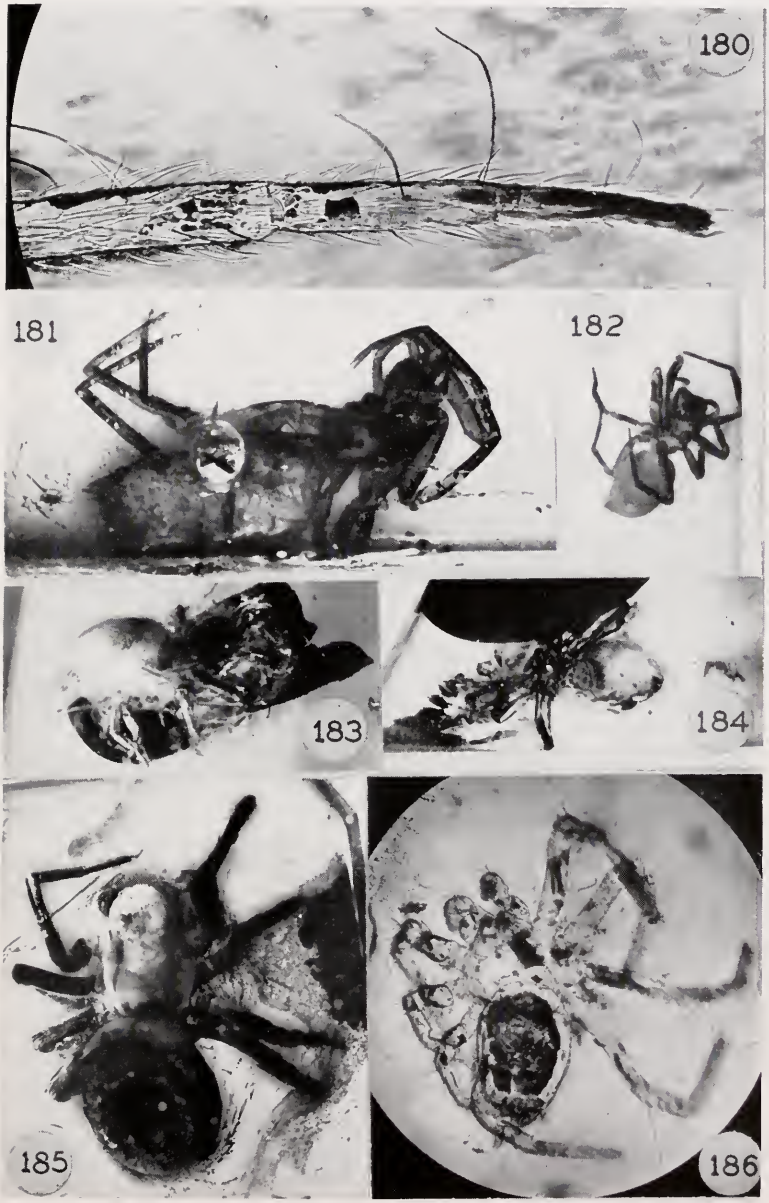
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## PLATE 24

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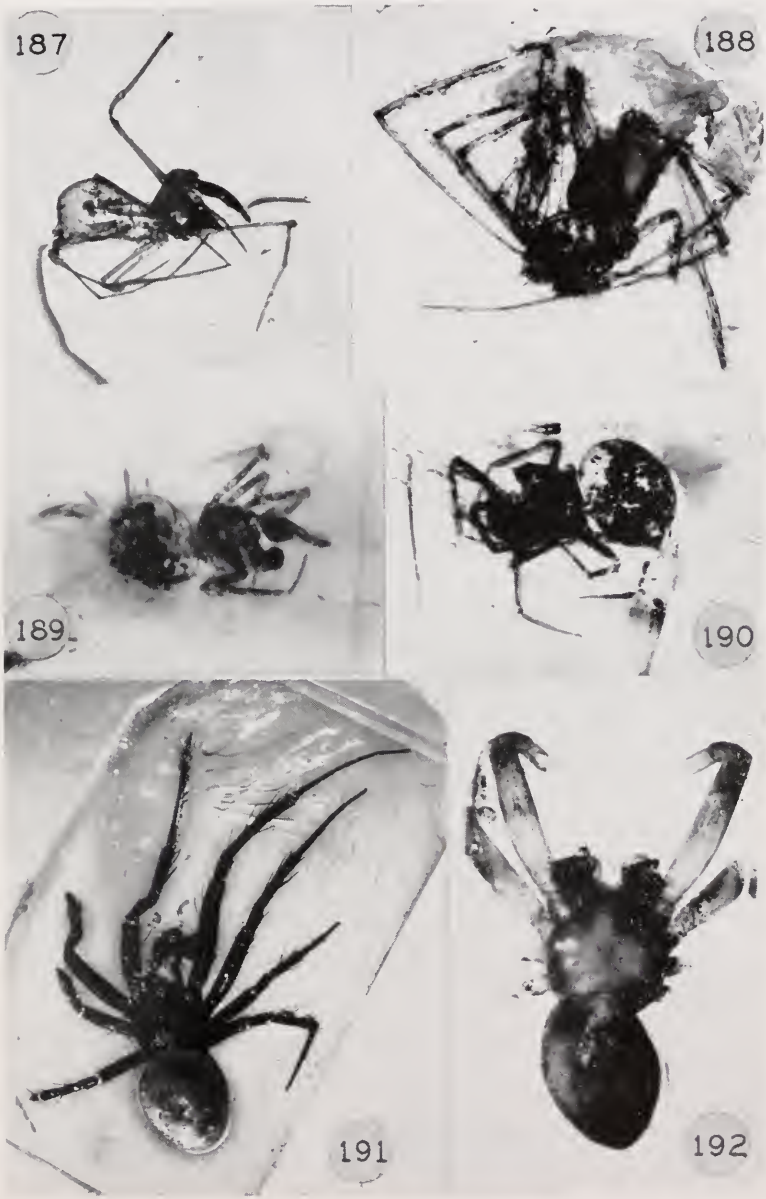
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## PLATE 25

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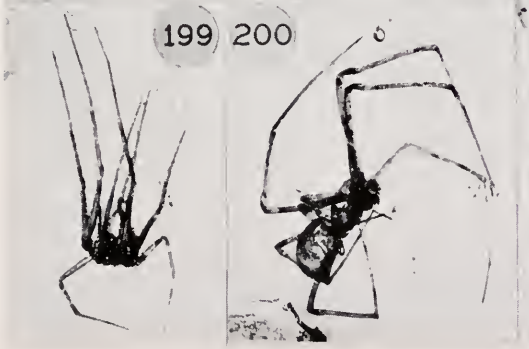
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PLATE 26

## PLATE 26

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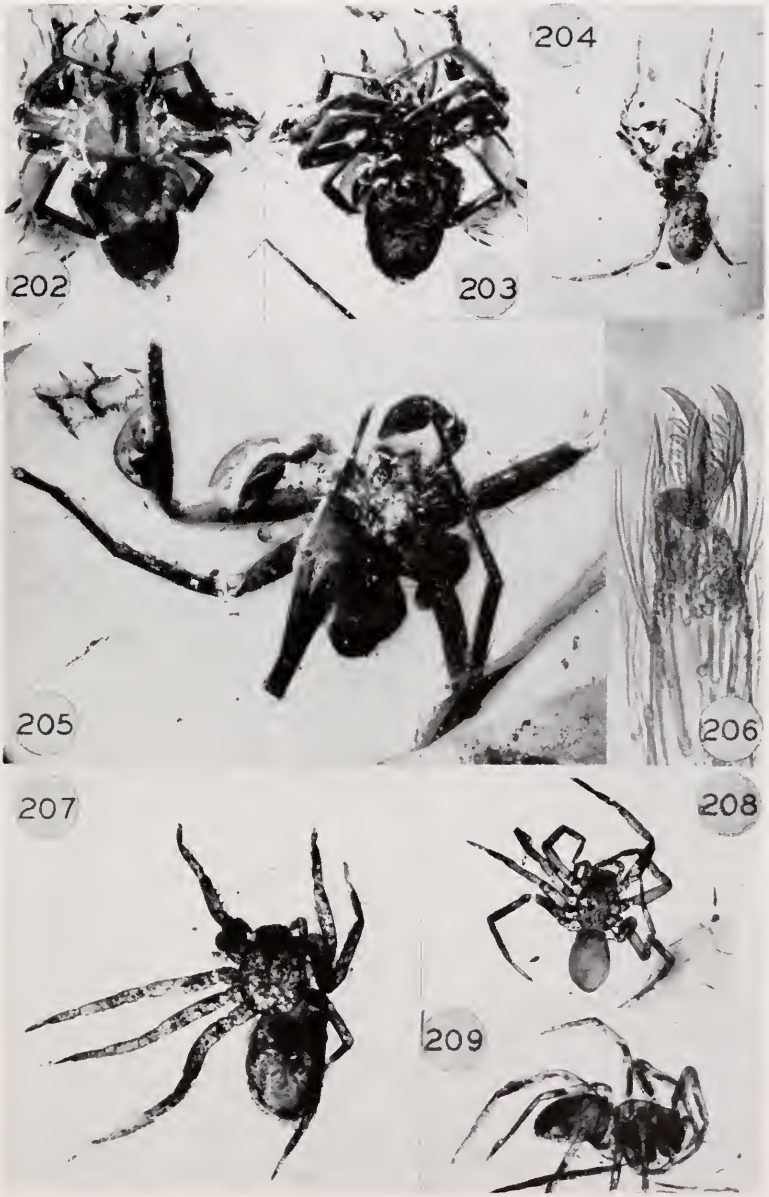
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PLATE 27

## PLATE 27

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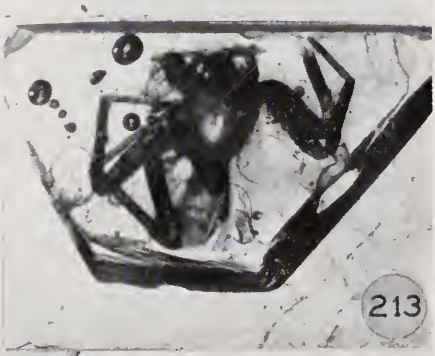
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# DISTRIBUTION AND ORIGIN OF THE BIRDS OF MEXICO

BY LUDLOW GRISCOM

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No. 6. — *Distribution and Origin of the Birds of Mexico*[1]

By Ludlow Griscom

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## PREFACE

The author's interest in the birds of Mexico and Central America has extended for a period of over thirty years. The present paper was a logical outcome of study in recent years, during which he has had the privilege of being associated with R. T. Moore and Dr. Herbert Friedmann in the preparation of a distributional check list of the birds of Mexico (cf. announcement, Auk, 1944, p. 173). He has examined specimens of every species of Mexican and Central American birds, nearly every genus and species of South American birds, and has had field experience in life with over two-thirds of the species analyzed beyond.

Every effort has been made to present the subject in a manner so as to make it as interesting as possible for naturalists in general, and to reduce to a minimum the necessity for expert systematic knowledge of tropical American birds to get the point of the argument. For this reason English names have been freely used for family, genus, and species, whenever familiar and available, but none have been invented. With the several long lists of migrants and visitants, all come from the

[1]Abstract presented to the Ecological Society of America, Chicago meeting, December, 1947, at a symposium on Mexico, and published with the aid of a special gift from Mr. George R. Agassiz.

United States, and all are such familiar and well known birds that space has been saved by not itemizing every species, with its technical and common name. Anyone interested can find this out for himself by consulting any standard bird guide or text-book. Similarly the long list of some 255 Sonoran endemics is not carried beyond a summary of each genus; the great majority of these species are known only to technical experts and possess no English names.

The division of Mexico into faunal areas or biotic provinces is outside the province of this paper, and is a study on which improvements will be made for another half century at least. Readers should recall that our knowledge of Mexican birds today is approximately equal to what ornithologists knew about the birds of the United States in 1875. For this reason there is no detailed description of the topography, climates and vegetative areas of the Republic, because these details are required chiefly to explain the distribution of local species within Mexico and innumerable subspecies. The best summary ever written of this subject (Nelson & Goldman, 1926) was prepared under the auspices of the Ecological Society of America, and there is no point in recapitulating it here.

## INTRODUCTION

Modern Mexico, in the political sense, has a relatively enormous avifauna of some 2200 named forms (species and subspecies) of birds, with another 150 in the adjacent republic of Guatemala. One bird in every 17 known on earth consequently occurs in this area. Factors of major importance are its central geographic position, and an exceedingly complex and varied topography, with a great diversity of climates and habitats. High mountain ranges and low valleys succeed each other with bewildering rapidity over the whole of the great tableland. Many widely ranging resident mountain and valley species constitute a series of isolated populations, which have existed in their present ranges sufficiently long to evolve a welter of local endemic subspecies. A steady stream of these are still being described. Some 1000 species are therefore represented by a total of 2350 subspecies. Even so, Mexico has been one of the last areas on earth to produce ornithological discoveries of note, three monotypic genera and several distinct species having been found there in the past twenty years.

Any broader analysis of the families, genera and species of birds of Mexico depends upon the app oach selected. The first and oldest approach to zoogeography was naturally a purely descriptive or geographic one. The zoogeographical Regions of Wallace and Sclater, into which the world was divided, accepted the conditions of the

present. Regions were characterized by possessing a striking number of peculiar families, subregions and faunas by peculiar genera and species, the many wide ranging ones dismissed as of no significance. The concept of these regions was based almost entirely upon the relatively well known mammals and birds. On this approach North America and most of Mexico was in the Nearctic Region, everything else was the Neotropical Region (including all high mountains and temperate South America!) and there was debate as to the existence of a Central American Subregion and just where the northern limits of the Neotropical Region were. I attempted to show that there was no such thing as a Central American Subregion and that the northern limits of the Neotropical Region were the narrow tropical lowlands of northern Central America and southern Mexico. (Griscom, 1932, 1940, 1945)

Criticism of this approach has been steadily accumulating for some decades. As the distribution of other animal groups, older in the historical or evolutionary sense, became better known it turned out not to fit at all or poorly, the degree of the misfit more or less in proportion to the greater antiquity of the group. The botanists proceeded to divide the world into phytogeographic areas, which presented a picture so hopelessly at variance with the zoological Regions, that no specialist in either field has dared to offer an attempted reconciliation for two generations.

In the meantime the fossil record of mammals, reptiles and a few other groups improved by leaps and bounds, and the picture of the proved or probable place of origin of many animals became clearer. There ceased to be much point in thinking of the so-called "characteristic" families of Neotropical mammals, for instance, as most of them proved to originate somewhere in the Northern hemisphere, and many of them were known to be recent immigrants to South America. (Matthew, 1915). This thesis was greatly extended by Simpson (1940). Dunn (1931) made a brilliant survey of the New World herpetological faunas, and received corroboration from Simpson (1943). This second method of approach may well be called the historical.

Chapman (1917, 1926) was actually the first ornithologist to attempt by analytical methods to deduce the probable or possible origin of tropical American bird life (the Andes of Colombia and Ecuador). He considered species and subspecies primarily and a percentage of the genera only, but left families severely alone. His methods were adopted by me in a study of the birds of Guatemala (1932), but a partial historical approach was attempted, and I was able to show (1) an older pre-glacial element, (2) an invasion from the North during glacial time, and (3) a recent invasion from the South with the return

of warmer climates, which has brought many Neotropical birds to their present northern limits with little or no evolutionary change. These conclusions were accepted by Chapman (1940, pp. 413–418), who had already indicated the "northern" origin of the so-called "Neotropical" family of motmots (1923), the "Neotropical" species, *Parula pitiayumi* (1925), and certain elements in the upper zonal bird life of Mt. Roraima and Mt. Duida (1931, p. 51). I adopted a primarily historical approach to a popular discussion of North American birds in Modern Bird Study (1945, chapt. IX, pp. 146–153), showing that (1) certain families were recent arrivals from the Old World; (2) others had invaded the New World at least twice, and that North America had been an important secondary center of evolution for the older element; (3) a group of families have been in the New World for so long a time, and they have undergone so much differentiation from their Old World relations, that it is impracticable to guess or infer just where they originated. Mayr (1946) made a thorough study of New World families along similar lines, but carried his speculations with certain families a little further than I care to go. Even so, about one third of the families remain unanalyzed (through no fault of his). His paper is chiefly remarkable for omitting all reference to most of the recent ornithological literature on the distribution and relationships of American birds. It has been criticized for suggesting sweeping systematic changes to suit his preconceived ideas, in my opinion unfairly, as none were original with him in this particular paper.

Simpson (1943, p. 414–415) has a sympathetic word to say about the difficulties of the ornithologist. Historical studies that are really conclusive are based on an adequate to excellent fossil record; they are particularly difficult, speculative and inconclusive, where the fossil evidence is hopelessly meager, as in birds. Again the Class Aves is the most homogeneous group of vertebrates. As Elliot Coues brilliantly said many decades ago, the differences between any two orders of birds approximate those between two families of reptiles. One result is that about half the birds on earth belong in one order, divided into innumerable "families of convenience" based on trivial and inconstant superficial characters. For every artificial family there is a peculiar genus of birds which will not fit into any! In several very large tropical American families based on internal characters (not determinable in the museum skin), hundreds of species are currently assigned to these families without a shred of evidence that they possess the necessary internal characters! Some day a radical rearrangement of all these families will become possible.

In the meantime there is far too much flogging of a horse already dead. Dr. Mayr is criticized, for instance, for transferring the peculiar

little gnatcatchers (*Polioptila*) from the Old World warblers, "Sylviidae", to the Old World flycatchers, "Muscicapidae," without giving any adequate reasons, and generations of Americans have been brought up to believe that the Muscicapidae did not occur in the New World. But actually these two "families" are mere sections of one family of Old World "insect-eaters". A minor point of routine taxonomy does not impair Dr. Mayr's main thesis that *Polioptila* is a highly modified little bird of undoubted Old World origin. Similarly it makes no difference whether the vireos are treated taxonomically as a family or a subfamily. Either way they are a readily recognizable little group of New World birds which developed in Middle America. Finally those naturalists interested in the historical approach rather than the geographic or descriptive approach would do well to recall that their studies could not have begun, until the geographical distribution of living orders, families and genera had become known with reasonable completeness. The facts of tertiary palaeontology would lack much of the interest they possess today, if we still had to start looking for the living descendants of these animals.

One natural result, however, is confusion in the use of certain terms, as they mean different things in these two methods of approach, and neither may be the routine popular usage. Thus, any traveller crossing the Tropic of Cancer has reached the tropics in a latitudinal sense. The avian geographer talking of the tropical zone birds of Mexico is thinking in terms of climate. The historical zoologist in talking of a tropical group of birds means that it evolved in a tropical climate, or now survives only in such a climate. In Temperate Chile is found a little woodpecker, *Dendrocopos lignarius*. The genus is widely distributed throughout the Northern hemisphere, few species occur in tropical climates, and in the New World the group is lacking between the mountains of Central America and temperate South America. The word fauna is therefore used in two radically different senses.

a. *Dendrocopos lignarius* is a member of the bird fauna of Chile, and actually is one of many striking genera and species endemic there, which collectively characterize and serve to define the well known Chilian South Temperate Faunal Area. Any competently observant naturalist visiting this fauna or faunal area for the first time could tell his first day afield that he had entered a new and different world. The fact that the ancestors of these striking birds may have migrated to Chile from very different directions, at different periods of time, and for different reasons, and that some of them may be genuinely autochthonous, does not invalidate this concept, or reduce it to mythology, as Dunn would have us believe.

b. The genus *Dendrocopos* is a member of an Old Northern, possibly

Palaearctic, Fauna which anywhere after late Tertiary time migrated all the way to southern South America, later becoming extinct and leaving one relict survivor behind. One of the elements in the bird life of Chile is, therefore, the Old Northern or Palaearctic Fauna.

Dunn recognized three faunal elements in the New World:

1) Holarctic — a modern, circumpolar element.
2) Old Northern — a more southern, older element.
3) South American — a still older element, developed during the long isolation of this continent in Tertiary time.

As all three elements could be recognized in nearly every part of Central and South America, he saw no point in trying to differentiate a Neotropical Region from a Nearctic Region, and his point is well taken.

Simpson suggests five regions or zones, from a "more directly zoogeographic viewpoint":

1) Boreal North America — the northern zone (Canadian Zone northward) characterized by Dunn's Holarctic fauna.
2) Middle North America — most of the United States.
3) Southern North America — chiefly Mexico, and Central America in the mountains.
4) Equatorial South America.
5) Austral South America — the cooler or temperate part, including the Andes at increasing altitudes northward.

These "regions" are to be thought of in a general way as important primary or secondary centers of evolution. Not only do they contain many peculiar families and endemic genera living today, but in at least three of them the fossil record proves the evolution of a rich and varied fauna in the past, now extinct or driven out by climatic change.

Geologically Mexico is an ancient land, always a southern extension of the continent of North America. A Central American land bridge existed into early Eocene time, but was broken into two or three islands during much of the Tertiary, and this land bridge was not restored until the middle or late Pliocene. A water gap across the isthmus of Tehuantepec existed from at least late Miocene to middle Pliocene time. The highlands of Chiapas, always connected with the Altos of Guatamala, were part of an island separated by the Nicaraguan gap from the mountains of Costa Rica and Western Panama, another island. There was consequently one barrier or another separating North from South America for most of the Tertiary, and the mingling of the mammal faunas ceased except for random vagrancy. This period of isolation is beautifully brought out in the mammals and indicated for some reptiles. Suddenly in late Tertiary time the North American mammals reached South America, but few if any new

families have evolved in the period of time involved. Unfortunately no such clear division can be made in the birds. In the first place too many of the passerine families are trivial, and in the second place, the restless motility of birds and their known powers of flight and dispersal would have greatly reduced the effect of these water gaps. All islands in the world, with adequate vegetation, have a varied land bird fauna, no matter how great the water gap, or how isolated from a continental land mass. Untold multitudes of land birds throughout the world today think nothing of migrating across the sea for much greater distances than were involved by any Middle American water gap, and the assumption that no land birds ever did it in Miocene time has nothing to support it. Considerable mingling of the Old Northern and the Old South American avifaunas in Middle America during the Tertiary can be assumed with confidence.

## ANALYSIS OF MEXICAN AVIFAUNA

With these few words of introduction, let us turn to an analysis of the rich bird life of Mexico, and see what can be done in spite of a hopelessly meager fossil record. The avifauna of Mexico can be divided into seven categories[1]. The word endemic is used in a faunal, and not a strictly political sense.

I. The more pelagic sea birds.

Three orders of birds have developed many highly pelagic or exclusively marine species. In many cases these birds spend the greater part of the year at sea, resorting chiefly to lonely and remote islands to breed. Mexico is bountifully possessed of such suitable islands off both coasts, and as a result has an exceptionally large list.

a) Breeding.

| | |
|---|---|
| Shearwaters (*Puffinus*) | 3 species |
| Petrels | 5 " |
| Tropic-bird (*Phaëthon*) | 1 " |
| Booby (*Sula*) | 4 " |
| Cormorant (*Phalacrocorax*) | 4 " |
| Bridled Tern (*Sterna anaetheta*) | 1 " |
| Sooty Tern (*S. fuscata*) | |
| Noddy (*Anoüs stolidus*) | 1 " |
| Fairy Tern (*Gygis alba*) | 1 " |

[1] Thorough taxonomic revisions along modern lines will reduce the number of genera currently recognized, and some species will also prove to be races of a more inclusive species.

Of these one genus (marked with an asterisk) and six species are endemic in the general area, as follows:

*Puffinus opisthomelas* (Black-vented Shearwater)
" *auricularis* (Townsend's Shearwater)
*Oceanodroma macrodactyla* (Guadalupe Petrel)
" *melania* (Black Petrel)
" *homochroa* (Ashy Petrel)
**Halocyptena microsoma* (Least Petrel)

b) Occurring as visitants off-shore.

| | |
|---|---|
| Albatross | 3 species |
| Shearwaters | 8 " |
| Petrels | 2 " |
| Tropic-bird | 1 " |
| Gannet (*Sula bassana*) | 1 " |
| Cormorant | 1 " |

It can be argued that the Cormorants do not strictly belong here, as not being sufficiently pelagic. They could variously be regarded as Old Northern or Nearctic. In all, only seven families are involved, all old and world-wide types of unknown origin.

II. West Indian Element.

The island of Cozumel (and adjacent islets in part) off the Yucatan Peninsula has long been famous for certain birds of obvious West Indian affinities. A few occur on the adjacent mainland of Yucatan. The flora of Yucatan is known to have a substantial West Indian element. Accidental arrival as a result of the frequent West Indian hurricanes is sufficient to account for both, rather than invoking a former land-bridge, highly speculative and unprovable. (Griscom, 1926b).

*Columbus dominicus dominicus* — the West Indian subspecies
*Phoenicopterus ruber* (Flamingo) — also Greater Antilles, north coast of South America, Galapagos
*Pandion haliætus ridgwayi* — the West Indian Fish Hawk
*Columba leucocephala* (White-crowned Pigeon) — typically Greater Antilles
*Zenaida aurita yucatanensis* — a race of the West Indian Zenaida Dove
*Leptotila jamaicensis gaumeri* — otherwise peculiar to Jamaica
*Crotophaga ani* — the West Indian species
*Tyrannus dominicensis* — the West Indian Gray Kingbird
*Elainea chinchorrensis* — closely related to the next
" *martinica remota* — otherwise on the Lesser Antilles

*Troglodytes martinica beani* — not a race of the continental *T. musculus*, Hellmayr not withstanding

*Vireo magister* — a curious species confined to this area and the keys and islands off British Honduras and Honduras. It has Antillean relatives, and may not be specifically distinct.

*Coereba bahamensis caboti* — very different from the mainland species, *C. mexicana*

*Dendroica petechia rufivertex* — nearest Lesser Antillean members of the group and distinct from the mainland form

*Spindalis zena benedicti* — the genus otherwise confined to the Greater Antilles

*Tiaris olivacea intermedia* — nearer Antillean members of the group, and distinct from the mainland form

These seventeen birds add twelve *species* only to the avifauna of Mexico of which one only might be regarded as endemic.

III. Widely ranging Element.[1]

Having already remarked on the powers of flight and the extreme motility of birds, we must now add a characteristic that makes so many of them difficult to analyze, and that is their extreme adaptability. The birds in this group are selected for one main reason only; many range not only throughout the tropics of the New World, but in temperate latitudes also. Moreover they are *resident* in their total ranges, the great extent of which is not due to migration. Chapman dismissed all birds in this category as of no zoogeographic significance. The imagination is staggered to reflect on the number of ecological associations, biotic provinces, and microclimates in which they are at home, which is reflected in considerable subspecific variation. The subject is well worth emphasizing to ecologists, as it explains why birds are about his poorest "indicators". The botanist recognizes a small number of aggressive weeds, but in most continents, the avifauna of any area within it consists of a sizable percentage of such birds. When to these we add the pan-tropical species, another very large list, and the northern species which migrate to far southern latitudes, a substantial percentage of the birds of the whole continent are involved, provided the area selected is *in or near the Northern Hemisphere*. It is not so true of South Africa, Australia and most of South America. This generalization may be taken to suggest the northern origin of most orders and older families of birds, and therefore these wide ranging birds may prove to have some zoogeographic significance after all.

[1]The classification and nomenclature adopted follow Peters, Check List of Birds of the World, and Hellmayr's volumes of the Catalogue of Birds of the Americas.

a) Occurring in both temperate and tropical latitudes and climates.

| | |
|---|---|
| Pelicanidae | Brown Pelican |
| Anhingidae | Anhinga |
| Fregatidae | 1 species resident plus 1 species visitor |
| Ardeidae | herons, 10 species |
| Cieoniidae | Wood Ibis |
| Threskiornithidae | ibis, 3 species |
| Anatidae | Cinnamon Teal and Fulvous Tree Duck |
| Cathartidae | New World vultures, 2 species |
| Accipitridae | hawks, 16 species |
| Falconidae | hawks, 11 species |
| Aramidae | Limpkin |
| Rallidae | rails, gallinules, 9 species |
| Jacanidae | Jacana |
| Haematopodidae | oyster-catcher, 1 species |
| Charadriidae | plover, 4 species |
| Himantopus | Black-necked Stilt |
| Laridae | terns, 6 species |
| Rynchopidae | Black Skimmer |
| Columbidae | *Columba fasciata*, Band-tailed Pigeon |
| | *Zenaidura macroura*, Mourning Dove |
| | *Zenaida asiatica*, White-winged Dove |
| | *Columbigallina passerina*, Ground Dove |
| Tytonidae | Barn Owl |
| [1]Strigidae | *Bubo virginianus*, Horned Owl |
| | *Speotyto cunicularia*, Burrowing Owl |
| Apodidae | *Cypseloides niger*, Black Swift |
| Tyrannidae | *Sayornis nigricans*, Black Phoebe |
| | *Pyrocephalus rubinus*, Vermilion Flycatcher |
| Hirundinidae | *Stelyidopteryx*, Rough-winged Swallow |
| Troglodytidae | *Troglodytes musculus* — House Wren |
| Vireonidae | *Vireo virescens*, Red-eyed Vireo and allies |
| Thraupidae | *Piranga flava* group, tanagers |
| Icteridae | *Cassidix major*, Great-tailed Grackle |
| | *Sturnella magna*, Meadowlark |

Certain general comments on this list are in order. Nineteen of the families are of nearly world-wide distribution, whose locus of origin is unknown, and I agree with Dr. Mayr that there is no use guessing at it. In many cases the genus, and in most cases the species, is a distinct New World type, but in which secondary center of evolution it originated is also anybody's guess. Of more interest in this connection are the cases where even the species is cosmopolitan, or at least occurs in parts of the Old World, such as the gallinule (*Gallinula*

[1] Also *Asio flammeus*, the Short-eared Owl, as a visitor.

*chloropus*), the Barn and Short-eared Owls. The families Cathartidae, Aramidae, Tyrannidae, Troglodytidae, Vireonidae, Thraupidae, and Icteridae are New World families. A fossil record indicates a Middle American origin for the first two, a preponderance of genera and species suggests a Middle and Warm North American origin for the wrens and vireos. The tanagers are chiefly tropical and South American. The tyrant flycatchers and Icteridae are large families with peculiar genera and species in every faunal subdivision of the New World except the arctic.

A more detailed discussion of the genera and species involved in this list is outside the province of this paper. By definition the occurrence of these birds in Mexico is a matter of common sense, and is not due to any factors specially characteristic of Mexico, which favor them. Its central position and varied terrain suffice. In some cases not even the latter factor applies. The Turkey Vulture hunts for food over every portion of Mexico, the ocean beaches, the deserts, the tropical forests and the highest mountain peaks.

b) Widely ranging in most of the New World tropics.

| | |
|---|---|
| *Colymbus dominicus* | Least Grebe |
| *Cochlearius cochlearius* | Boat-billed Heron |
| *Dendrocygna autumnalis* | Black-bellied Tree-duck |
| *Nomonyx dominicus* | Masked Duck |
| *Sarcorhamphus papa* | King Vulture |
| *Odontriorchis palliatus* | Snail-hawk |
| *Chondrohierax uncinatus* | do |
| *Buteo magnirostris* | |
| *Hypomorphnus urubitinga* | Black Hawk |
| *Busarellus nigricollis* | River Hawk |
| *Geranospiza nigra* | Crane Hawk |
| *Aramides cayanea* | Wood Rail |
| " *axillaris* | do |
| *Columbigallina talpacoti* | Ruddy Ground Dove |
| *Leptotila verreauxi* | White-fronted Ground Dove |
| *Oreopeleia montana* | Ruddy Quail-Dove |
| *Amazona ochrocephala* | Yellow-crowned Parrot |
| *Coccyzus minor* | Mangrove Cuckoo |
| *Piaya cayana* | Squirrel-Cuckoo |
| *Tapera naevia* | Striped Cuckoo |
| *Crotophaga sulcirostris* | Groove-billed Ani |
| *Ciccaba virgata* | Brown Wood Owl |
| " *nigrolineata* | Barred Wood Owl |
| *Rhynoptynx clamator* | Striped Horned Owl |
| *Glaucidium minutissimum* | Pygmy Owl |
| " *brasilianum* | do |

| | |
|---|---|
| *Asio stygius* | Tropical Long-eared Owl |
| *Nyctibius griseus* | Pootoo, a special New World family |
| *Chordeiles acutipennis* | Trilling Nighthawk |
| *Nyctidromus albicollis* | Parauque |
| *Streptoprocne zonaris*[1] | White-collared Swift |
| *Chaetura rutila*[1] | Chestnut-collared Swift |
| *Phaethornis superciliosus* | Hermit Hummingbird |
| *Chlorostilbon caniveti* | Emerald Hummingbird |
| *Heliomaster longirostris* | do |
| *Ceryle torquata* | Ringed Kingfisher |
| *Chloroceryle amazona* | Green Kingfisher |
| " *americana* | Little Green Kingfisher |
| *Piculus rubiginosus* | Green Woodpecker |
| *Dryocopus lineatus* | Tropical Pileated Woodpecker |
| *Veniliornis oleaginus* | Oily Woodpecker |
| *Muscivora tyrannus* | Fork-tailed Flycatcher |
| *Tyrannus melancholicus* | Couch's Kingbird |
| *Legatus leucophaius* | |
| *Myiodynastes maculatus* | |
| *Megarhynchus pitangua* | Boat-billed Flycatcher |
| *Myiozetetes similis* | |
| *Pitangus sulphuratus* | Derby Flycatcher |
| *Myiarchus tyrannulus* | |
| " *tuberculifer* | |
| *Myiochanes cinereus* | Gray Wood Pewee |
| *Elainea flavogaster* | |
| " *viridicata* | |
| *Tityra semifasciata* | Family Cotingidae |
| *Progne chalybea* | Gray-breasted Martin |
| *Iridoprocne albilinea* | Mangrove Swallow |
| *Thryothorus rutilus* | Rufous-breasted Wren |
| *Polioptila plumbea* | Gnatcatcher, Family Sylviidae |
| *Dendroica petechia* | Mangrove Warbler |
| *Habia rubica* | Ant-Tanager |
| *Eucometis penicillata* | Crested Tanager |
| *Saltator coerulescens* | Gray Saltator |
| *Sporophila minuta* | Red-breasted Seed-eater |
| *Volatinia jacarina* | Glossy Seed-eater |

This list of birds brings out several interesting points. The very great majority of the families are in *exactly the same* category as in the first list, but only six genera and one species occur in the Old World. Of the remaining genera, only twelve have other species which penetrate into temperate North America. We meet some new families for the first time. The Nyctibiidae or Potoos are an equatorial South

[1] Might be included in group a with equal propriety.

American family, only one species of which reaches Mexico and the West Indies. The Cotingidae are also primarily South American, and the number of genera and species rapidly decreases as we proceed northward in Central America. The three finches belong to a special New World subfamily, the Richmondeninae, chiefly South American; the genera *Saltator* and *Sporophila* are also chiefly South American, and in both genera only one species each is endemic north of the Panama isthmus. The hummingbirds, Trochilidae, are in the same category as the Tyrannidae. We note, therefore, the strengthening of the strictly New World elements, and meet a South American element for the first time, a mere handful of aggressive species.

IV. The true Neotropical or South American Element.

a) Widely ranging throughout tropical America, but chiefly confined to *humid rain forest* areas on the eastern coast of Central America, absent or rare and local on the Pacific coast north of the Nicaraguan isthmus.

| Family | | |
|---|---|---|
| Tinamidae | *Tinamus major* | Great Tinamou |
| | *Crypturellus soui* | |
| Ardeidae | *Agamia agami* | Agami Heron |
| | *Tigrisoma lineatum* | Tiger Bittern |
| Ciconiidae | *Jabiru mycteria* | Jabiru |
| Accipitridae | *Harpagus bidentatus* | Tooth-billed Kite |
| | *Accipiter bicolor* | |
| | *Leucopternis albicollis* | White Hawk |
| | *Harpia harpyja* | Harpy Eagle |
| Columbidae | *Columba cayannensis* | Pigeon |
| | *Columbigallina minuta* | Least Ground Dove |
| | *Claravis pretiosa* | Blue Ground Dove |
| Psittacidae | *Ara macao* | Scarlet Macaw |
| | *Amazona autumnalis* | |
| | " *farinosa* | |
| Cuculidae | *Dromococcyx phasianellus* | Pheasant-Cuckoo |
| Strigidae | *Lophostrix cristata* | |
| | *Pulsatrix perspicillata* | Spectacled Owl |
| Apodidae | *Panyptila cayannensis* | Fork-tailed Swift |
| Trochilidae | *Phoethornis longuemareus* | Hermit Hummer |
| | *Florisuga mellivora* | Jacobin Hummer |
| | *Thalurania furcata* | Purple Wood-Nymph |
| Trogonidae | *Trogon collaris* | Collared Trogon |
| | " *violaceus* | |
| Alcedinidae | *Chloroceryle aenea* | Least Kingfisher |
| Momotidae | *Momotus momota* | Motmot |

| | | |
|---|---|---|
| Bucconidae | *Notharchus hyperrhynchus* | Puff-bird |
| Formicariidae | *Taraba major* | Great Ant-shrike |
| | *Thamnophilus doliatus* | Barred Ant-shrike |
| | *Thamnistes anabatinus* | |
| | *Microrhopias quixensis* | Ant-Wren |
| | *Myrmotherula schisticolor* | Slaty Ant-Wren |
| | *Cercomacra tyrannina* | Tyrannine Ant bird |
| | *Formicarius analis* | Ant-Thrush |
| Furnariidae | *Automolus ochrolaemus* | |
| | *Xenops minutus* | |
| | *Sclerurus mexicanus* | |
| Dendrocolaptidae | *Dendrocolaptes certhia* | Wood-hewer |
| | *Lepidocolaptes souleyetii* | |
| | *Glyphorhynchus spirurus* | |
| | *Sittasomus griseicapillus* | |
| Tyrannidae | *Platyrinchus mystaceus* | Flat-billed Flycatcher |
| | *Tolmomyias sulphurescens* | |
| | *Todirostrum cinereum* | Tody-Tyrant |
| | " *sylvia* | |
| | *Leptopogon amaurocephalus* | |
| | *Pipromorpha oleaginea* | |
| Pipridae | *Schiffornis turdinus* | Thrush-like Manakin |
| Cotingidae | *Cotinga maynana* | Blue Cotinga |
| | *Attila spadiceus* | |
| | *Pachyramphus cinnamomeus* | |
| | *Tityra inquisitor* | |
| Troglodytidae | *Henicorhina leucosticta* | Black-capped Wood-Wren |
| Vireonidae | *Hylophilus ochraceiceps* | |
| | *Cyclarhis gujanensis* | Pepper Shrike |
| Coerebidae | *Cyanerpes cyaneus* | Blue Honey-creeper |
| | *Coereba flaveola* | Banana-quit |
| Thraupidae | *Tangara nigro-cincta* | Paradise Tanager |
| | *Thraupis episcopus* | Blue Tanager |
| Icteridae | *Amblycercus holosericeus* | Prevost's Cacique |
| | *Psomocolax oryzivorus* | Rice Grackle |
| | *Icterus mesomelas* | Oriole |
| Fringillidae | *Saltator maximus* | |
| | *Cyanocompsa cyanoides* | Blue Rice Grosbeak |
| | *Tiaris olivacea* | Seed-eater |
| | *Arremon aurantiirostris* | Red-billed Sparrow |
| | *Arremonops conirostris* | Green Sparrow |

b) Mexico to west Ecuador in humid tropical rain forest.

| Family | | |
|---|---|---|
| Cracidae | *Crax rubra* | Currasow |
| | *Penelope purpurascens* | Guan |

| | | |
|---|---|---|
| Heliornithidae | *Heliornis fulica* | Sun-Grebe |
| Eurypygidae | *Eurypyga helias* | Sun-Bittern |
| Trochilidae | *Amazilia tzacatl* | |
| Galbulidae | *Galbula melanogenia* | Jacamar |
| Bucconidae | *Malacoptila panamensis* | Puff-bird |
| Furnariidae | *Sclerurus guatemalensis* | |
| Tyrannidae | *Myiobius sulphureipygius* | |
| | *Rhynchocyclus brevirostris* | |
| | *Microtriccus semiflavus* | |
| Pipridae | *Pipra mentalis* | Yellow-thighed Manakin |
| Cotingidae | *Lipaugus unirufus* | Piha Cotinga |
| Vireonidae | *Hylophilus decurtatus* | |
| Icteridae | *Zarhynchus wagleri* | Wagler's Oropendola |
| | *Icterus chrysater* | Oriole |
| Fringillidae | *Sporophila aurita* | Black and White Seed-eater |
| | *Oryzoborus funereus* | Black Rice Grosbeak |

c) Mexico and Central America only, a few species reaching north Colombia in humid tropical rain forest.

| Family | | |
|---|---|---|
| Tinamidae | *Crypturellus boucardi* | Boucard's Tinamou |
| Phasianidae | *Odontophorus guttatus* | Spotted Partridge |
| Columbidae | *Columba nigrirostris* | Black-billed Pigeon |
| | *Leptotila plumbeiceps* | |
| | " *cassini* | |
| Psittacidae | *Aratinga astec* | Aztec Parrakeet |
| | *Pionopsitta haematotis* | Red-eared Parrot |
| | *Pionus senilis* | White-headed Parrot |
| Trochilidae | *Anthracothorax prevosti* | Mango Hummer |
| | *Paphosia helenae* | Coquette Hummer |
| | *Hylocharis eliceae* | |
| | *Amazilia candida* | |
| Momotidae | *Hylomanes momotula* | Tody Motmot |
| | *Electron carinatus* | Green Motmot |
| Trogonidae | *Trogon massena* | Massena Trogon |
| Ramphastidae | *Ramphastos piscivorus* | Toucan |
| | *Ptcroglossus torquatus* | Collared Toucan |
| Picidae | *Celeus castaneus* | Chestnut Woodpecker |
| Dendrocolaptidae | *Dendrocincla homochroa* | |
| | " *anabatina* | |
| Tyrannidae | *Onychorhynchus mexicanus* | Royal Flycatcher |
| Pipridae | *Manacus candei* | Bearded Manakin |
| Vireonidae | *Smaragdolanius pulchellus* | Emerald Vireo |
| Thraupidae | *Tanagra lauta* | Bonaparte's Euphonia |
| | " *gouldi* | Gould's Euphonia |
| | *Ramphocelus passerinii* | Crimson-rumped Tanager |

| | | |
|---|---|---|
| | *Phlogothraupis sanguinolentus* | Crimson-collared Tanager |
| | *Habia gutturalis* | Ant-Tanager |
| | *Lanio aurantius* | Black and Yellow Tanager |
| Icteridae | *Gymnostinops montezuma* | Chestnut Oropendola |
| | *Icterus prosthemelas* | Oriole |
| Fringillidae | *Saltator atriceps* | |
| | *Caryothraustes poliogaster* | Black and Yellow Grosbeak |

d) Widely ranging throughout tropical America, chiefly in humid rain forest, but in the Subtropical[1] or even the Temperate Zone.

| Family | | |
|---|---|---|
| Columbidae | *Claravis mondetoura* | Ground Pigeon |
| | *Oreopeleia linearis* | Quail-Dove |
| Psittacidae | *Bolborhynchus lineola* | Barred Parrakeet |
| Strigidae | *Otus guatemalae* | Screech Owl |
| Trochilidae | *Colibri thalassinus* | Violet-eared Hummer |
| | [2]*Campylopterus hemileucurus* | Purple Sabre-wing |
| Trogonidae | *Pharomachrus mocinno* | Paradise Trogon; Quetzal |
| Ramphastidae | *Aulacorhynchus prasinus* | Green Toucanet |
| Formicariidae | *Grallaria guatimalensis* | Ant-Pitta |
| Furnariidae | *Xenicopsoides montanus* | |
| | *Automolus rubiginosus* | Ruddy Automolus |
| Dendrocolaptidae | *Dendrocolaptes picumnus* | Wood Hewer |
| | *Xiphocolaptes promeropirhychus* | Red-billed Wood Hewer |
| | [2]*Lepidocolaptes affinis* | Reaches sea level in N. E. Mexico |
| Tyrannidae | *Mitrephanes phaeocercus* | Crested Pewee |
| Troglodytidae | *Henicorhina leucophrys* | White-browed Wood-Wren |
| Turdidae | [2]*Turdus ignobilis* | Dusky Robin |
| | [3]*Myadestes unicolor* | Slaty Solitaire |
| Coerebidae | *Diglossa baritula* | |
| Parulidae | *Myioborus miniatus* | Tropical Redstart |
| | *Basileuterus culicivorus* | |
| Thraupidae | [2]*Chlorophonia occipitalis* | Emerald Euphonia |
| | *Piranga leucoptera* | White-winged Tanager |
| | *Chlorospingus ophthalmicus* | |
| Fringillidae | *Spodiornis rusticus* | |
| | *Atlapetes gutturalis* | Yellow-throated Sparrow |
| | " *brunneinucha* | |
| | " *torquatus* | |

This long list of birds, divided into four sections, brings out many interesting points:

[1] Many people prefer the term upper Tropical.

[2] Ranging from Mexico to western Panama only.

[3] Ranging from Mexico to northern Nicaragua only.

| | |
|---|---|
| Total number of families represented | 33 |
| Chiefly tropical American | 6 |
| " South American | 12 |
| Total number of genera represented | 130 |
| Cosmopolitan | 4 |
| New World | 6 |
| Tropical American | 21 |
| South American | 99 |

Only one genus is restricted to Central America, the tanager, *Phlogothraupis*, based on minor technicalities. In marked contrast to the last list, Group III b, the South American element is overwhelmingly preponderant.

A study of the species involved yields further evidence, using those belonging to the primarily South American genera.

| | |
|---|---|
| Total number of such species in Mexico | 148 |
| Ranging from Mexico — Amazonia | 90 |
| " " " — Ecuador west of the Andes | 18 |
| " " " — Panama or north Colombia | 37 |
| Endemic in Mexico and northern Central America | 1 |

It must be born in mind that the ninety-nine genera involved have some two thousand species in South America, and that the primarily South American families possess at least two hundred other genera. It should be clear that only a mere tinge of this South American avifauna has penetrated north to southern Mexico. In only thirty-eight cases has specific change taken place north of the Colombian Andes, and further exploration will undoubtedly reduce some of them to subspecies. Of the eighty-nine widely ranging species, no less than thirty-six decrease rapidly northward in Central America, and they are so rare in southern Mexico, that in several cases only 1–3 specimens have ever been collected. The table below considers a great South American family, the Formicariidae or Ant-birds, and shows graphically how it decreases northward in Central America, in spite of the continuity of the rain forest. All the larger South American families would show precisely similar results.

| Formicariidae | Genera | Species |
|---|---|---|
| Total number known | 55 | 233 |
| Ranging north to western Panama | 18 | 27 |
| " " " Nicaragua | 17 | 21 |
| " " " Guatemala | 11 | 11 |
| " " " Mexico | 8 | 8 |

We should now recall that during the period of extreme Pleistocene glaciation, the humid tropical forests must have been far south of their present limits, which were attained or regained with the arrival of less rigorous conditions. At the same time the upper Tropical Zone, at least, descended to sea level, and the birds again reascended the mountains, thus accounting for their present discontinuous distribution. To sum up, the accumulated evidence fully justifies the hypothesis that some of the birds at least in Group IV, must represent a recent invasion from the south. The ancestors of some of them may well have originated in far earlier geological eras in North America (Cracidae and Aramidae, for instance) and reached South America in Eocene time or by hopping the Central American Islands during the Tertiary, but South America has clearly been their major evolutionary center, from which a small percentage have radiated northward from late Tertiary time on, with little or no evolutionary change.

The next element in the avifauna of Mexico is a very small but particularly interesting one. A small group of species peculiar to middle America, and chiefly in the arid tropical Pacific lowlands, have no near allies. Another group of relict species provide cases of a remarkable degree of discontinuous distribution, or else they have been left stranded, as it were, in Mexico or Central America, while their relations moved southward, and developed along other lines. Each case requires treatment in considerable detail; otherwise only an expert in tropical American birds would get the point.

V. Preglacial relicts, which have been in Mexico a very considerable length of time. Endemics are marked with an asterisk; the term is used in a faunal, not a political sense.

a) Species of limited range, but never restricted to humid tropical rain forest, and commonest in or confined to the arid tropics. Endemic species marked with an asterisk.

| Family | | |
|---|---|---|
| Tinamidae | *Crypturellus cinnamomeus* | Mexico to N. W. Costa Rica, chiefly in the arid tropical zone on the Pacific Slope |
| Ardeidae | *Heterocnus cabanisi* | Mexico to Panama, on both coasts |
| Cracidae | *Ortalis vetula* | U. S. A. to Nicaragua, in arid and humid tropics |
| | **Ortalis wagleri* | Arid tropics of west Mexico |
| Psittacidae | *Aratinga canicularis* | W. Mexico to N. W. Costa Rica, arid tropics |

| | | |
|---|---|---|
| | *Amazona albifrons* | Mexico to N. W. Costa Rica |
| | **Amazona xantholora* | Arid portion of Yucatan Peninsula |
| Picidae | *Phlœoceastes guatimalensis* | Mexico to Panama, both coasts |
| Tyrannidae | *Oncostoma cinereigulare* | Mexico to W. Panama, chiefly arid tropics |
| Pipridae | *Chiroxiphia linearis* | W. Mexico to N. W. Costa Rica, arid tropics |
| Cotingidae | *Pachyramphus major* | N. W. and N. E. Mexico to Nicaragua, in both tropics and mountains |
| | *Platypsaris aglaiæ* | U. S. border to Costa Rica, in both arid and humid tropics and the mountains |
| Troglodytidae | *Heleodytes zonatus* | Mexico to W. Panama, reappearing in W. Ecuador; variously in arid and humid tropics and mountain pine forests |
| | *Thryophilus modestus* | Mexico to W. Panama, arid tropics |
| | " *pleurostictus* | Mexico to N. W. Costa Rica, arid tropics |
| Turdidae | *Turdus assimilis* | Mexico to N. Colombia, arid and humid tropics |
| | *Turdus grayi* | Mexico to N. Colombia, arid and humid tropics |
| Parulidae | *Euthlypis lachrymosa* | Mexico to Costa Rica, arid tropics |
| Thraupidae | **Tanagra godmani* | Arid tropics of W. Mexico |
| | " *affinis* | W. Mexico to N. W. Costa Rica, arid tropics |
| | *Thraupis abbas* | Mexico to Nicaragua, chiefly arid tropics |
| Fringillidae | *Sporophila torqueola* | Mexico to Costa Rica, arid and humid tropics |
| | *Arremonops rufivirgatus* | Mexico to Costa Rica, chiefly arid tropics |
| | *Cyanocompsa parellina* | A very distinct species of an otherwise South American genus, chiefly in the arid tropics of Mexico and northern Central America |

This list could be greatly extended by adding other species from the Pacific coast of Central America, which do not range north into Mexico.

Readers should notice, at once, that five of the families represented are world-wide in distribution, of great antiquity in the New World, and there need be no surprise that endemic species have been evolved

in so marked an ecological niche as the arid tropical lowlands of Middle America. Two of the genera, *Heterocnus* and *Euthlypis*, are endemic. The New World families are either primarily South American, or if not, the genera represented are. In these cases the species is so distinct as to have no obvious relations further south. The only exception is *Crypturellus cinnamomeus*, now stranded in its present range, cut off from relatives in west Ecuador and the Orinoco Valley. It is, therefore, my conviction that these species originated in preglacial time in the general area where they are now found, and by one means or another survived the Ice Age.

In addition to this historical factor there is a most important ecological one, which has never been brought out.

1. The humid tropical rain forest on the eastern coastal plain of Mexico and Central America requires eighty to two hundred plus inches of rain, distributed *throughout the year*, to develop. It is absolutely continuous, crosses the continent at the Isthmus of Panama, and extends into South America on both the Pacific and Caribbean coasts. It follows that all more aggressive types of birds can wander north or south as they please, remaining in a uniform environment.

2. The arid tropical zone of the Pacific lowlands has a rainfall of twenty-five to eighty inches a year in a pronounced wet season, followed by a *prolonged dry season*. According to the amount of rain, either a scrub forest or a high gallery forest is produced. Rain shadows caused by the central mountain masses divide the Pacific lowlands into sharply contrasting belts of scrub and gallery forest, and the birds partial to each are, therefore, isolated in a series of ecological islands. Ecological discontinuity is consequently the outstanding characteristic of the Pacific coastal plain of middle America. The net result is a large number of endemic species, of very limited range. Only *one* bird, the Parrakeet, *Brotogerys jugularis*, all the other members of the genus being South American, has the distinction of ranging continuously from Amazonia up the Pacific coast of America to Chiapas.

All these points will receive renewed emphasis when we examine the group of "relict" birds which come next. The two groups are not sharply differentiated, and several of the species belong as well in one list as the other. Note that only one of the birds in the list which follows is confined to humid tropical rain forest.

b) Preglacial Relicts

The term "relict", as constantly used by the zoogeographer, requires definition, since it is not the current one in the dictionary. It implies a species of animal of very limited range, so widely separated from

close relatives that the usual reasons for discontinuous distribution do not apply or do not satisfactorily explain it. These usual reasons are obviously 1) the required climate is discontinuous. 2) the required habitat is discontinuous, or 3) both are discontinuous. Unknown, unfavorable factors in the past history of species or genus are, therefore, implied and presumed; they became extinct in the intermediate area. These relicts are, therefore, in the same category as the relict animals of the palaeontologist, but the fossil record to prove it is lacking. Thus the two living species of elephants, and tapirs in tropical America, are relicts of once abundant and widely distributed groups, particularly in North America. But while the survival of the tapirs in South America is so easily understandable as almost to be a matter of common sense, I doubt if even the palaeontologist can suggest why elephants did not survive also.

Let us consider the little parrots of the genus *Forpus*, which live in the arid and humid tropics and subtropics of South America. It is impossible to see why they should not range over most of Central America also. Since the same fact, however, is true of innumerable other genera, we infer that they originated in South America, and have not been sufficiently aggressive to push northward, after the Central American land bridge became available in the late Tertiary. This theory is demolished by the discovery of a distinct species, *F. cyanopygius*, in the arid tropical coastal plain of northwestern Mexico. Moreover a study of this bird in its native environment makes it impossible to understand why it does not occupy the whole Pacific coast of Mexico, or for that matter the arid tropics of Central America. Similarly the recently discovered tufted jay, *Cyanocorax dickeyi*, in a mountain range in Sinaloa, occurs at an altitude and in a type of montane forest widely distributed in western, central and southern Mexico, and all its associated species are widely distributed.

Non-ornithological readers must, therefore, assume the existence of similar unexplainable factors in the list of birds which follows.

Family Cracidae — of middle or warm North American origin, now widely distributed, chiefly South American.

**Oreophasis* — A remarkable genus in the high mountains of Chiapas and Guatemala, sometimes regarded as a special subfamily.

**Penelopina* — Endemic in the Subtropical Zone of Chiapas south to northern Nicaragua.

Family Burhinidae — an old, relict group of Shore birds with a very wide but interrupted distribution.

*Burhinus bistriatus* — locally in savannas on the Pacific Slope of Mexico and Central America, reappearing in Ecuador and Peru.

Family Psittacidae

*Ara militaris* is common in the mountains of Mexico, reappearing in the Andes from Colombia to Bolivia.

*Aratinga holochlora* ranges from northwestern Mexico to Nicaragua. It is a zonally inconstant species, characteristic of the arid tropics of the Pacific lowlands, but also widely scattered in montane pine forests. It has no near relative in the genus and furnishes an ideal illustration of a bird which defies ecological classification.

**Forpus cyanopygius*, a species of northwestern Mexico, chiefly in the arid tropics. The genus reappears in South America, where numerous species are widely distributed in both the arid and humid tropics.

**Amazona viridigenalis* is endemic in northeastern Mexico, chiefly in the Tamaulipan Biotic Province. Its nearest relative is

**Amazona finschi*, endemic in western Mexico in the arid tropics. Other species range widely throughout tropical America.

Recalling the endemic genus *Rhynchopsitta* (p. 368) and the extinct *Conuropsis* of the U. S. (Miocene time-Recent), the Old Northern or North American origin of New World Parrots is suggested.

Family Caprimulgidae — world wide, of unknown origin.

*Caprimulgus maculicaudus* — recently discovered in Oaxaca, is widely distributed in tropical South America.

Family Apodidae — world wide, but chiefly tropical; of unknown origin.

**Streptoprocne semicollaris* — a very rare species of the mountains of Central Mexico. Another species is widely distributed throughout the New World in tropical latitudes. A third is in eastern Brazil.

Family Trochilidae — a remarkable pan-American group with many centers of evolution.

**Campylopterus curvipennis* — restricted to tropical southeastern Mexico and Guatemala. Related to *largipennis* of eastern South America.

**Campylopterus rufus* — endemic in the mountains of Guatemala, its only relative, *hyperythrus*, on the summit of Mt. Roraima.

*Amazilia rutila* — arid tropical zone of Mexico and Central America.

**Amazilia yucatanensis* — its closest relative, on the Caribbean slope from Texas to British Honduras. Two very distinct species in a large and varied pan-tropical genus.

*Heliomaster constantii* — a very distinct species of the arid tropical zone of Mexico and northern Central America. Other species reappear in southeastern Brazil.

Family Trogonidae — a pan-tropical family, with a marked center of development and evolution in middle or warm North America.

*Trogon citreolus* and *melanocephalus* — tropical zone, chiefly arid, in Mexico and northern Central America.

**Trogon mexicanus* — temperate zone, chiefly in mountain pine forest, Mexico to Honduras.

*Trogon elegans* — zonally inconstant, from southern Arizona to Costa Rica; some subspecies in mountain pine forests, others in the arid tropics.

Family Momotidae — a family of warm or middle North American origin, only a few elements of which have reached South America.

**Aspatha gularis* — an endemic genus of the mountains of southern Mexico to Honduras, chiefly in oak forests.

*Eumomota superciliaris* — a monotypic genus, endemic in the arid tropics from southern Mexico to Costa Rica.

**Momotus mexicanus* — arid tropical zone, western Mexico and the interior desert of Guatemala.

Family Furnariidae — a vast family, primarily developed in South America, with a steadily diminishing number of genera and species as we proceed northward in Central America.

*Synallaxis erythrothorax* — a distinct species of southern Mexico and northern Central America, related to a group of South American species, unrepresented in southern Central America.

Family Dendrocolaptidae — for comments see preceding family.

*Xiphorhynchus flavigaster* — chiefly arid tropical zone in southern Mexico to Costa Rica. Its only close relative in a large South American genus is

**X. striatigularis* — known from only one specimen from southern Tamaulipas.

**Lepidocolaptes leucogaster* — a peculiar species confined to western Mexico, in the arid tropical and subtemperate zones, very different from all other species of a large South American genus.

Family Hirundinidae — one of the few distinct families of oscine Passeres, of world-wide distribution and unknown origin.

*Petrochelidon fulva* — a relict species with a remarkably interrupted distribution, the Greater Antilles, northeastern Mexico and Texas, Yucatan, west Ecuador and Peru.

Family Corvidae — of world-wide distribution, but with an important center of development in middle and warm North America; very few members have reached South America.

**Cyanocorax dickeyi* — a remarkable recent discovery, known from a high mountain range in Sinaloa. Other species referred to this genus are South American, one ranging north into southern Central America.

*Xanthoura yncas* — the Green Jay (a very poor monotyic genus) is common in the arid and humid tropics of Mexico, Guatemala and northern Honduras. It reappears in the Subtropical zone of the Andes from Colombia and Venezuela to Bolivia.

Family Troglodytidae — a New World family with an important evolutionary center in warm North America, and another in South America.

**Hylorchilus sumichrasti* — a very rare bird restricted to three known localities in the tropical rain forests of Vera Cruz. Its relatives are *Leucolepis* and *Microcerculus*, which are primarily Amazonian genera.

Family Mimidae — a New World group, with several centers of evolution in Middle America, very few reaching South America.

*Mimus gilvus* — distribution curiously disconnected; Lesser Antilles, northern South America, also southeastern Mexico to eastern Honduras

Family Turdidae — a nearly cosmopolitan family, with several centers of differentiation in the New World.

**Turdus infuscatus* — humid temperate zone in the mountains of southern Mexico to Honduras. One of a group of "all black" species scattered in high mountains south to Argentina.

Family Parulidae — a New World family of middle or warm North American origin, very few genera reaching South America.

**Granatellus venustus.*

**G. sallaei* — two rare and local species of the tropical zone of southwestern and southeastern Mexico and Peten. The genus reappears in Amazonia.

Family Thraupidae — a New World family richly developed in South America, the number of genera and species rapidly decreasing northward in middle America.

*Tanagra elegantissima* — mountains of southern Mexico to western Panama. One of a group of "blue capped" species, reappearing in the Andes and the West Indies.

**Tangara cabanisi* — known from only two specimens from Chiapas and western Guatemala, humid tropical zone of Pacific Slope; most closely related to *T. palmeri* of western Colombia. A vast genus of South America, very few species ranging north into middle America.

*Rhodinocichla rosea* — a monotypic genus of uncertain family affinities, locally in the tropics of western Mexico, reappearing in western Panama, and again on the coast of Colombia and Venezuela.

Family Icteridae — a characteristic New World family, with numerous centers of development.

**Cassiculus melanicterus* — a monotypic genus of the arid tropics of western Mexico, belonging to a large group of "hang-nests" or caciques, primarily South American, chiefly in rain forest.

*Dives dives* — a monotypic genus, zonally quite inconstant in southern Mexico to Nicaragua, reappearing in western Ecuador and Peru.

Family Fringillidae — the largest family of birds, absent in Australia. There are three well marked subfamilies, but unfortunately too many of the tropical American genera cannot as yet be assigned, for lack of the proper anatomical studies. One subfamily, Richmondeninae, is primarily South American, the Emberizinae are primarily North American, and the Carduelinae are primarily Old World and Boreal.

*Pheucticus chrysopeplus* — a species of the arid tropics of western Mexico and Guatemala, which reappears in South America from Colombia to Peru.

**Rhodothraupis celaeno* — a monotypic genus of the Tamaulipan Biotic Province. Its closest relative is *Periporphyrus* of the Guianas.

**Amaurospizopsis relictus*— a very rare monotypic genus in the mountains of Guerrero, is very closely related to the rare *Amaurospiza*, which is found in the humid tropics of Central America, west Ecuador, and Brazil.

*Sicalis luteola* — a very common finch throughout South America, reappears as a very rare bird in the high mountains of southern Mexico and Guatemala.

**Atlapetes pileatus* — a genus of innumerable species in South America scarcely any northward. The present species of the Mexican Plateau is very distinct.

*Atlapetes albinucha* — a species of the mountains of southern Mexico, reappearing in Colombia without even racial variation!

Comparative Table for Humid and Arid Tropical Lowlands Species

| | Caribbean | Pacific |
|---|---|---|
| Common to both | 154 | 154 |
| Mexico to South America | 107 | 1 |
| Endemic, Central America to Mexico | 38 | 52 |
| Endemic, Mexico and Guatemala | 0 | 19 |

As we shall see later, the apparent poverty of the avifauna of the Pacific coast of Mexico and Central America, is compensated for by many endemic genera and species of middle or warm North American (old Northern) affinities, which have entered the present tropical lowlands.

VI. Old Northern Element, the existing species and genera, of the present, characteristically middle or warm North American.

a) Primarily or presumably middle North American in origin and range.

1) Breeding in some part of Mexico at least.

| Family | | |
|---|---|---|
| Anatidae | *Erismatura jamaicensis* | Ruddy Duck |
| Accipitridae | *Accipiter cooperi* | Cooper's Hawk |
| | " *striatus* | Sharp-shinned Hawk |
| | *Buteo lineatus* | Red-shouldered Hawk |
| Falconidae | *Falco mexicanus* | Prairie Falcon |
| Meleagrididae | *Meleagris gallopavo* | Wild Turkey |
| Rallidae | *Coturnicops noveboracensis* | Yellow Rail |
| Charadriidae | *Oxyechus vociferus* | Killdeer Plover |
| | *Pagolla wilsonia* | Wilson's Plover |
| Laridae | *Larus occidentalis* | Western Gull |
| | " *atricilla* | Laughing Gull |
| Cuculidae | *Coccyzus americanus* | Yellow-billed Cuckoo |
| Strigidae | *Otus asio* | Screech Owl |
| | *Glaucidium gnoma* | Pygmy Owl |
| Caprimulgidae | *Caprimulgus vociferus* | Whippoorwill |
| Apodidae | *Chaetura vauxi* | Vaux's Swift |
| Tyrannidae | *Myiochanes virens* | Wood Pewee |
| | *Empidonax difficilis* | Western Flycatcher |

| Family | | |
|---|---|---|
| Hirundinidae | *Progne subis* | Purple Martin |
| | *Petrochelidon pyrrhonota* | Cliff Swallow |
| | *Tachycineta thalassina* | Violet-green Swallow |
| Corvidae | *Corvus brachyrhynchos* | American Crow |
| | *Cyanocitta stelleri* | Steller's Jay |
| | *Cyanocephalus* | Pinon Jay |
| Cinclidae | *Cinclus mexicanus* | American Dipper |
| Troglodytidae | *Thryothorus ludovicianus* | Carolina Wren |
| | *Thryomanes bewickii* | Bewick's Wren |
| | * " *insularis* | Socorro Isl. Wren |
| | *Cistothorus platensis* | Short-billed Marsh Wren |
| Mimidae | *Mimus polyglottos* | Mockingbird |
| Turdidae | *Turdus migratorius* | American Robin |
| | *Sialia sialis* | Bluebird |
| Vireonidae | *Vireo griseus* | White-eyed Vireo |
| | " *solitarius* | Blue-headed Vireo |
| | " *gilvus* | Warbling Vireo |
| Parulidae | *Parula pitiayumi* | Pitiayumi Warbler |
| | *Dendroica audubonl* | Audubon's Warbler |
| | *Geothlypis trichas* | Northern Yellow-throat |
| Thraupidae | *Piranga rubra* | Summer Tanager |
| | *Piranga ludoviciana* | Western Tanager |
| Icteridae | *Molothrus ater* | Cowbird |
| | *Icterus spurius* | Orchard Oriole |
| | *Agelaius phoeniceus* | Red-winged Blackbird |
| Fringillidae | *Hedymeles melanocephalus* | Black-headed Grosbeak |
| | *Ammodramus savannarum* | Grasshopper Sparrow |
| | *Passerculus sandwichensis* | Savanna Sparrow |
| | *Junco oregonus* | Oregon Junco |
| | *Spizella passerina* | Chipping Sparrow |
| | *Zonotrichia capensis* | Chingolo Song Sparrow |
| | *Melospiza melodia* | Song Sparrow |

2) Migrants, and winter visitors, breeding in temperate or middle North America.

| | |
|---|---|
| Western Grebe | Nighthawk |
| White Pelican | *Caprimulgus*, Chuck-will's-widow |
| American Bittern | Chimney Swift |
| Wood Duck | Belted Kingfisher |
| Hawks (*Buteo*, 3 species) | Picidae, Sapsucker |
| King Rail | Tyrannidae, 11 species |
| Shore Birds (Limicolae), 7 species | Swallows, 2 species |
| Laridae, 3 species | Wrens, 2 species |
| Passenger Pigeon | Mimidae, Catbird and Sage Thrasher |
| Black-billed Cuckoo | Thrushes, 8 species |

| | |
|---|---|
| Sprague's Pipit | Icteridae, 5 species |
| Cedar Waxwing | Fringillidae: |
| Vireos, 2 species | Richmondeninae, 4 species |
| Parulidae (Wood Warblers), 34 species | Carduelinae, *Spinus*, 2 species |
| Scarlet Tanager | Emberizinae, 15 species |

Readers should note the following points:

1. Every species is endemic in temperate North America, regardless of genus or family; the great majority are migratory. Only one is restricted to Mexico.

2. No less than 46 genera, and one family, the turkeys or Meleagrididae, are endemic.

3. Ten families are now primarily tropical in distribution, and every species involved is highly migratory, wintering in the tropics. The only exceptions are the two Phoebes of the genus *Sayornis*, a Tyrannid genus, whose relatives are all in temperate South America.

4. The northern limits of all these birds must have been shrunk by 800–1000 miles at the period of maximum Pleistocene refrigeration, and their present ranges represent a recapture of a great extent of territory.

5. Only ten species range south of Mexico for varying distances in the mountains of Central America, or the Andes (*Cistothorus platensis* only).

6. Only 6 species have penetrated into tropical climates south of the Mexican tableland, where they have evolved distinct subspecies. Only two species, *Parula pitiayumi* and *Zonotrichia capensis* are now widely distributed in South America (cf. Chapman, 1925, 1940).

7. Only two of the endemic genera, *Junco* and *Thryomanes*, have endemic species on the highest mountain peaks of Costa Rica, the avifauna of which is in part old North American.

b) Endemic genera and species, chiefly confined to Mexico, adjacent parts of Central America and the adjacent southwestern United States. Endemic genera are marked with an asterisk, and specific names are omitted in monotypic genera.

| Family | |
|---|---|
| Anatidae | *Anas diazi*, Mexican Black Duck |
| Cathartidae | **Gymnogyps californianus*, California Condor |
| Phasianidae, Odontophorinae, New World only | |
| | **Dendrortyx*, all 3 species of Tree-Quail, one south to the mountains of Costa Rica |
| | **Oreortyx*, Mountain Quail |
| | **Callipepla*, Scaled Quail |

| Family | |
|---|---|
| | **Lophortyx*, all 3 species, one arid tropical |
| | **Philortyx* |
| | *Colinus virginianus*, 14 subspecies out of some 17, some arid tropical |
| | *Colinus nigrogularis*, arid tropical. Bob-White |
| | **Dactylortyx* |
| | **Cyrtonyx*, both species of Ocellated Quail |
| Meleagrididae | **Agriocharis*, Ocellated Turkey, arid tropical |
| Laridae | Heermann's Gull and Elegant Tern |
| Columbidae | *Columba flavirostris*, Red-billed Pigeon |
| | *Zenaidura graysoni*, Socorro Isl. Mourning Dove |
| | *Scardafella inca*, Inca Dove |
| Psittacidae | **Rhynchopsitta*, 2 species in mountain pine forest. Thick-billed Parrots |
| Cuculidae | **Geococcyx*, both species of Road-runner |
| | *Morococcyx*, arid tropical |
| Strigidae | *Otus*, 4 species, one arid tropical. Screech Owls |
| | **Micrathene*, Elf Owl |
| Caprimulgidae | **Otophanes*, both species of Eared Poor-wills |
| | *Caprimulgus*, 2 species, both arid tropical |
| Apodidae | **Aeronautes*, White-throated Swift |
| Trochilidae | **Cynanthus*, both species |
| | *Hylocharis*, 2 species |
| | *Amazilia*, 3 species |
| | **Eupherusa*, 2 species; others in mountains of Costa Rica and W. Panama |
| | **Lampornis*, 3 species; others in mountains of Costa Rica and W. Panama |
| | **Lamprolaima* |
| | **Eugenes*, also in mountains of Costa Rica |
| | **Doricha* |
| | **Tilmatura* |
| | **Calothorax*, both species |
| | **Abeillia* |
| | **Archilochus colubris*, migratory, in eastern U. S. |
| | **Archilochus alexandri* |
| | *Calypte*, 2 species |
| | **Stellula calliope*, migratory northward in U. S. |
| | **Atthis* |
| | **Selasphorus*, 3 species, 2 migratory northward in U. S.; others in high mountains of Costa Rica |
| Trogonidae | **Euptilotis*, Eared Trogon |
| Picidae | *Colaptes*, 3 species of Flicker |
| | *Centurus*, 5 species, several in arid tropics |
| | *Melanerpes formicivorus*, south to the mountains of Costa Rica |

| Family | |
|---|---|
| | *Campephilus imperialis*, Imperial Ivory-billed Woodpecker |
| | *Dendrocopos*, 4 species |
| Tyrannidae | *Muscivora forficata*, migratory northward in U. S. |
| | *Tyrannus*, 3 species, 1 arid tropical, 2 migratory in the U. S. |
| | *Myiodynastes luteiventris*, migratory |
| | *Myiarchus*, 4 species, 3 arid tropical, 1 migratory |
| | **Deltarhynchus* |
| | *Myiochanes pertinax*, migratory northward |
| | **Aechmolophus* |
| | *Empidonax*, 5 species, 2 migratory northward |
| | **Xenotriccus* |
| | *Camptostoma imberbe*, Beardless Flycatcher |
| Hirundinidae | **Progne sinaloae*, Sinaloa Martin |
| | *Atticora pileata*, Coban Swallow |
| Corvidae | *Corvus cryptoleucus* and *imparatus*, White-necked Raven and Mexican Crow |
| | **Calocitta*, Magpie-Jay, arid tropics |
| | **Psilorhinus*, both species, arid and humid tropics. Brown Jay |
| | **Cissilopha*, all 4 species, 3 in arid tropics |
| | *Cyanolyca*, 4 species, also in mountains of Costa Rica |
| | **Aphelocoma*, all 3 species, 1 subspecies isolated in Florida |
| Paridae | *Parus*, 4 species of Chickadee |
| | **Auriparus*, Verdin |
| | **Psaltriparus*, Bush-tit |
| Troglodytidae | *Heleodytes*, 6 species, some arid tropical. Cactus Wrens |
| | *Thryothorus*, 3 species, partly arid tropical |
| | *Troglodytes*, 3 species, one arid tropical |
| | **Nannorchilus*, Short-tailed Wren |
| | **Salpinctes*, Rock Wren |
| | **Catherpes*, Canyon Wren |
| Mimidae | *Toxostoma*, 9 species, one other in eastern U. S. Thrashers |
| | **Melanotis*, both species |
| | **Melanoptila*, arid tropics, Yucatan and Cozumel Isl. Black Catbird |
| | **Mimodes*, confined to Socorro Isl. |
| Turdidae | *Turdus*, 2 species of Robin |
| | *Myadestes obscurus*, a Solitaire |
| | *Catharus*, 5 species |
| | **Ridgwayia* |
| | *Sialia mexicana*, Chestnut-backed Bluebird |
| Sylviidae | *Polioptila*, 3 species, 1 migratory subspecies in eastern U. S. Gnatcatchers |

| Family | |
|---|---|
| *Ptilogonatidae | **Ptilogonys*, both species |
| | **Phainopepla* |
| | N.B. The remaining genus, *Phainoptila*, in the high mountains of Costa Rica. |
| Vireonidae | *Vireo*, 9 species, some in U. S. migratory |
| | **Neochloe* |
| | **Vireolanius*, Shrike-Vireo |
| Parulidae | *Vermivora*, 4 species, 3 migratory |
| | **Peucedramus*, Olive Warbler, migratory northward |
| | *Dendroica*, 2 species |
| | *Geothlypis*, 5 species |
| | **Chamaethlypis*, south to Costa Rica |
| | **Cardellina*, Red-faced Warbler |
| | *Setophaga picta*, Painted Redstart |
| | **Ergaticus*, both species of Pink Warblers |
| | *Basileuterus*, 2 species |
| Thraupidae | *Piranga*, 3 species, 2 in arid tropics. Tanagers |
| Icteridae | *Tangavius aeneus*, Red-eyed Cowbird |
| | *Cassidix*, 2 species, 1 subspecies in eastern U. S. Great-tailed Grackles |
| | *Icterus*, 12 species, several in arid tropics. Orioles |
| | *Agelaius tricolor*, Tricolored Red-wing |
| Fringillidae | *Richmondena cardinalis*, 13 out of 17 subspecies, several in arid tropics. Cardinal |
| | **Pyrrhuloxia* |
| | **Guiraca caerulea*, 1 subspecies in eastern U. S. Blue Grosbeak |
| | *Passerina*, 4 species, one migratory in U. S., and arid tropics |
| | *Spinus*, 3 species of Siskin |
| | *Pipilo*, 5 species of Towhee |
| | **Melozone*, all 4 species, one south to Costa Rica |
| | **Plagiospiza*, Striped Sparrow |
| | **Xenospiza* |
| | *Aimophila*, 11 species, several in arid tropics, one south to Costa Rica |
| | **Amphispiza*, both species, Desert Sparrows |
| | *Junco phaeonotus*, Yellow-eyed Junco |
| | *Spizella*, 2 species |

First of all I hasten to repeat an earlier caution on taxonomic points. Future study will reduce the number of genera (already proposed in some of the jays), and some of the species, notably in *Heleodytes* and *Aimophila*. Another caution on an earlier page must also be repeated. The term, endemic, is used in a faunal sense, not a strictly political one. It is quite impossible to analyze the avifauna of Mexico, disregarding

the adjacent southwestern United States, and the mountain ranges south of Chiapas and Guatemala, where similar climates and major ecological habitats are continuous.

1. The families represented include 11 plus 1 subfamily, whose members are now primarily tropical in distribution. In every case those species which breed north well into the United States are highly migratory and winter in the tropics.

2. Only two species have entered the humid tropics, as part of their range only (*Psilorhinus*).

3. Note that a substantial percentage of the total avifauna of arid tropical Mexico is composed of endemic species belonging to North American families and genera.

4. Only six species have one or more subspecies in the eastern U. S., east of the Great Plains.

5. Only two genera have a distinct species in the eastern U. S. The Ruby-throated Hummingbird, *Archilochus colubris*, breeds exclusively in the eastern U. S., joining its western relative, *alexandri*, in Mexico in winter. The genus *Toxostoma* (Thrashers) has the species *rufum* in the eastern United States, closely related to *longirostre*.

6. Such cases furnish an excellent illustration of the possibility for endless debate. Did *Toxostoma* originate in middle America, because of the presence of *rufum*, in which case Mexico was a secondary center of evolution? Or did the genus originate in Mexico, with one aggressive species entering the eastern U. S.?

7. There is no hard and fast line, separating the species in group a from group b. I therefore, decline to hazard any guess as to whether these genera and species originated in Middle or Warm North America.

8. The dubious propriety of attempting to do so is even better brought out in studying the last element in the avifauna of Mexico.

VII. Birds belonging to the modern Holarctic or circumpolar element of Dunn and Simpson.

| Family | Breeding in Mexico | Visitant |
|---|---|---|
| Gaviidae, Loons | | 3 species |
| Colymbidae, Grebes | Eared Grebe | |
| Anatidae, Swans | | 2 species |
| Geese | | 4 species |
| Ducks | | 17 species |
| Mergansers | | 3 species |
| Accipitridae, Hawks | Goshawk | |
| | Golden Eagle | |
| | Bald Eagle | |
| | Marsh Hawk | |

| Family | Breeding in Mexico | Visitant |
|---|---|---|
| Falconidae, Falcons | | *Falco columbarius*, |
| Gruidae, Cranes | | 2 species |
| Rallidae, Rails | | *Porzana carolina*, |
| Chararadriidae, Plover | | 6 species |
| Scolopacidae, Shore Birds | | 20 species |
| Phalaropodidae, Phalaropes | | 3 species |
| Stercorariidae, Jaegers | | 3 species |
| Laridae, Gulls and Terns | | 11 species |
| Alcidae, Auks, etc. | Auks, 3 species | Auks, 2 species |
| Strigidae, Owls | Saw-whet Owl | Long-eared Owl |
| Picidae, Woodpeckers | *Dendrocopos villosus* | |
| Alaudidae, Larks | Horned Lark (*Otocorys*) | |
| Corvidae, Crows | Raven | |
| | *Nucifraga* (Clarke's Nutcracker) | |
| Paridae, Titmice | *Parus gambeli* | |
| Sittidae, Nuthatches | *Sitta*, 2 species | |
| Certhiidae, Creepers | *Certhia familiaris* | |
| Chamaeidae | **Chamaea*, the Wren-Tit | |
| Sylviidae, Warblers | *Regulus satrapa* | *R. calendula* |
| Motacillidae, Pipits | | *Anthus spinoletta* |
| Laniidae, Shrikes | Loggerhead Shrike | |
| Fringillidae, Finches | *Hesperiphona vespertina* | |
| | * " *abeillei* | |
| | **Carpodacus mexicanus*, and 2 other species | |
| | *Spinus pinus*, Pine Siskin | |
| | *Loxia curvirostra*, Red Crossbill | |

1. Note that only one genus and two species are endemic in Mexico and the Western U. S.

2. *Hesperiphona* is the only non-arctic North American genus. It is closely related to the Asian *Mycerobas*. It might be put in group VIa with some propriety.

3. The species divide about equally into 2 groups. About half are distinct representative North American species. Thus, the Bald Eagle, *Haliæetus leucocephalus*, clearly represents the Old World *H. albicilla*, the Sea Eagle, and the Redhead duck replaces the Pochard. In about half the cases, the species is common to both hemispheres, a tendency which increases northward as we approach the arctic.

4. The only basis for not putting those species in the first category above in Group VIa is 1) they belong in world-wide or Holarctic genera, or primarily Old World families, instead of New World genera or families, and 2) the breeding range of the species extends north into Boreal North America.

5. In five cases, the species ranges south of Guatemala in high mountains. The Hairy Woodpecker reaches western Panama, and the Horned Lark reappears in high mountain savannahs in the Andes of Colombia. Every species concerned represents a recent Pleistocene invasion from the North, as far as its Mexican and Central American range is concerned.

6. The pros and cons debated here show the final impossibility of guessing the origin of any of these birds, with no fossil record. Actually it makes all the difference in the world whether we are thinking of the origin of the family, genus or species. In some cases fossils give us clues as to the locus of origin of the family, very rarely for certain old genera, never for the species. In the whole order Passeres, the welter of Modern "families" cannot have any locus of origin determined by fossils, as these families possess no known osteological characters!

7. The historically minded ornithologist must resort to some method of analysis, similar to that adopted here. The family is the primary unit. It locus of origin is determined by a fossil record; this may be safely assumed, if it is confined to a limited geographic area, or if, as with the Creepers, or Certhiidae, it is an Old World family, with some subspecies of one species only in North America. Widely ranging families usually have several secondary centers of evolution, groups of genera and species, either in different hemispheres or in different parts of the New World; it is a pure guessing game, which of these centers, if any, may have been the primary one. In some families there is only one obvious present day center of evolution, and it is tempting to infer that it is primary rather than secondary. All too often early fossils have turned up in some part of the world where the family is now extinct.

8. The final speculative trap is the endeavor to date the arrival of a supposed Old World family in the New World as early or recent on the basis of the degree that the New World representatives are different from their congeners. While this is unquestionably valid in many cases, a margin of error is bound to exist, as there is the implied premise that all groups of birds vary or evolve into new species and genera at about the same degree of evolutionary speed. The systematist can prove that this is not true, and in some cases the fossil record also proves it. Thus the Cranes and Grouse have been in North America since Eocene time, but the two cranes are only specifically distinct, whereas there are a welter of peculiar genera and polymorphic species in the latter. I therefore conclude that the game-birds are more plastic than cranes.

9. For these reasons I decline to push the historical analysis of Mexican birds any further than done in this paper.

We are now prepared to present a summary of the results in tabular form.

Summary of Mexican Species Analyzed

| | Resident | Visitant |
|---|---|---|
| Pelagic sea birds | 21 | 16 |
| West Indian element | 12 | 0 |
| Widely ranging element: | | |
| Temperate and tropical | 88 | 2 |
| Tropical only | 65 | 0 |
| South American element | 147 | 0 |
| Preglacial relicts | 68 | 0 |
| Old North American element: | | |
| Middle North America | 52 | 125 |
| Sonoran endemics | 255 | 0 |
| Modern Holarctic element | 25 | 83 |
| Totals | 733 | 226 |
| Grand Total | 959[1] | |

Summary of Endemic Genera and Species

| | Genera | Species |
|---|---|---|
| Pelagic sea birds | 1 | 6 |
| West Indian element | 0 | 0 |
| Widely ranging | 0 | 0 |
| South American | 0 | 0 |
| Preglacial relicts | 7 | 27 |
| Old North American element: | | |
| Middle American | 0 | 1 |
| Sonoran | 60 | 255 |
| Modern Holarctic | 1 | 3 |
| | 69 | 292 |

## CONCLUSIONS

a) Ecological

1. No less than 165 resident species and 210 visitants are so widely ranging in the New World as to defy ecological classification. Only 76 of them require a tropical climate.

2. 117 species of the South American element are confined and absolutely dependent upon humid tropical rain forest; 29 others require rain forest, but in subtropical or temperate climates.

[1] By no means including all species recorded from Mexico. Some are stragglers. The special species of Guatemala and the high mountains of Costa Rica are not counted.

3. The pre-glacial relicts occur in various climates, including arid temperate (montane pine forest), but not in deserts.

4. The Middle North American element barely enters tropical climates and deserts, but otherwise most of the species are sufficiently adaptable to defy ecological classification. Most are "woodland" species or prefer "fields" or "savannahs", or "water" habitats.

5. The modern Holarctic element also barely enters an arid tropical or desert climate, but otherwise most of the species are adaptable, many of them amazingly so. It is suggested that the adaptability shown by these birds is in part responsible for their ability to breed in north temperate latitudes, their survival of the Ice Age, and their recapture of much territory since the recession of the ice.

6. The Sonoran endemics are about evenly divided between the deserts, the arid tropics, and montane forests, both humid and arid (pine and oak).

7. The occurrence of the pelagic sea birds is almost wholly on ecological grounds, so far as we know.

8. Any further analysis along ecological lines brings us to the Biotic Province. This has recently been as well done as possible for Mexico by Goldman and Moore, 1945, a paper to which interested readers are referred. No real improvement can take place until the botanists catch up with the much better known mammals and birds.[1]

b) Zoogeographical

1. To those who prefer the old fashioned descriptive method of approach, the table-land of Mexico, and a strong element in the higher mountains of Central America, are an integral part of North America.

2. Descending from this table-land and entering the humid tropical forests of southeastern Mexico, we encounter another 146 species of birds, which either range into South America, or whose relatives are wholly South American. As we proceed southward in Central America, this list has risen to 400 species by the time we reach eastern Costa Rica This humid tropical belt is an integral part of the Neotropical Region. Endemism is very low.

3. Scattered here and there in Mexico are a few "relict" species of South American affinities.

4. The arid tropical zone of the Pacific coastal plain of western Mexico and the arid tip of the Yucatan Peninsula (Griscom, 1926a). possess a minor element of birds of South American or "Neotropical" affinities. The majority are modified, and endemism is high. The

[1] Actually this is a third method of approach to the study of the biota of any substantial portion of the earth's surface. Its validity will be discussed in another connection in the much better known areas of the eastern United States.

major element in the avifauna is composed of highly modified birds of North American origin and relationships.

5. The Subtropical Zone, as expounded by Chapman in the Andes, is destroyed in Mexico and Guatemala. This belt of rain or cloud forest with a subtropical climate, exists in Guatemala, and is found in Mexico in Vera Cruz, in the Transverse Volcanic Axis, and in the Sierra Madre del Sur in Guerrero (Griscom, 1934). Only 25 species, characteristic of this Zone, in the Andes and the mountains of southern Central America, range north to Mexico. This very marked habitat in Mexico is filled by modified birds of North American affinities.

6. The balance of Mexico is in the Temperate Zone, which reaches sea level in northwestern and northeastern Mexico. As we approach the United States border in the mountains, the familiar Life-Zones of North American zoologists become ever more sharply defined. We meet familiar birds in the Transition and Canadian Zone oak, pine, fir and spruce forests at higher levels. The bird-life of the Upper Sonoran yellow pine forest and the lower Sonoran deserts is almost identical across the international boundary.

7. Still continuing Chapman's system of describing and naming Faunas in Colombia and Ecuador, Mexico can also be divided into Faunal Areas. These are so nearly coextensive with the Biotic Provinces of Goldman and Moore (1945), as to require no further discussion at this time. Interested readers will note, however, the degree to which subspecies rather than species and genera have to be used as "indicators", another way of showing how widely ranging most avian genera and species are. Further details, and longer lists of the flora, mammals and birds can also be obtained from the chapter on Mexico in the Naturalists Guide to Americas. (Nelson and Goldman, 1926.)

8. Out of a total of 733 breeding species, no less than 39% are endemic. The Sonoran endemics alone constitute 34% of the resident avifauna.

9. In addition to these endemic species, local variations among them produce over 1000 endemic subspecies. To these must be added 69 endemic genera, and three peculiar North American families, the Turkeys, the Ptilogonatidae or Silky Flycatchers, and the currently recognized Vireolaniidae or shrike-vireos.

10. Moreover, Mexico has been an evolutionary center for many North American families and genera, the American Quail, the motmots, the vireos, the woodpeckers of the genera *Dendrocopos* and *Centurus*, the orioles (*Icterus*), the wrens and emberizine sparrows, to mention only a few. Every known genus of American Quail occurs in Mexico, while seven out of 9 are endemic. In the sparrow genus *Aimophila*, 11 out of 13 species are endemic.

11. The last three items in combination serve to define and characterize the Sonoran Subregion, the equivalent of Simpson's "Warm North America", which an analysis of modern birds validates perfectly.

12. The Sonoran Subregion includes the southwestern United States, and the southern coastal prairies and Edwards Plateau sections of Texas; southward it continues in the mountains of Central America to western Panama; some of its characteristic birds range south in tropical climates on the Pacific coast to northwestern Costa Rica. Northward some of its characteristic birds breed at higher altitudes in the Sierras and Rocky Mountains, migrating southward in winter.

13. The New World is readily divisible into the five "regions" of Simpson, plus a sixth on the basis of modern birds.

a. Boreal or Holarctic North America — very limited in variety, but with 3 peculiar families and many genera.

b. Middle North America — no endemic family, but a variety of genera and species in the United States, in addition to those listed in this paper, which reach Mexico.

c. Warm North America — as defined above, the third richest in endemics.

d. Equatorial South America — the greatest number of peculiar families, many genera and a vast number of species, some extending north to southern Mexico.

e. Andean South America — the Subtropical and Temperate Zones from Costa Rica to Bolivia; another great welter of genera and species, but 9 equatorial families are lacking; the second richest.

f. Temperate or Austral South America — five special families, many endemic genera, but a limited variety of species. Includes the Paramo Zone of the Andes.

14. The ornithologist can see no more reason for combining sections d and e, than sections b and c.

15. Dunn's strictures on the old concept of the Neotropical Region are largely correct. The inclusion of the avifauna of Temperate South America in the Neotropical Region is absurd; its disconformity is even greater than that between the Holarctic and Middle North America.

16. Sections b and c could be combined as subregions into a North American Region (the term Nearctic is misleading). The Neotropical Region should be restricted to sections d and e.

17. Most new World Families of birds occur in all six of these "regions". Old ideas about the "Neotropical" families of birds go back to a period when an analysis of so called "Nearctic" birds stopped at the U. S.-Mexican boundary, and all families occurring south of the Tropic of Cancer were spoken of as "tropical American".

18. Actually only twelve small families of birds occur exclusively in tropical climates today. The hummingbirds, Trochilidae, for instance, and the Tyrants (Tyrannidae), supposed by Dr. Mayr to be "probably originally South American," show the absurdity of this view-point. Actually two thirds of the genera and species of Hummingbirds do not occur in the tropics, and about half of the tyrants. Warm North America has been a major evolutionary center for both.

19. Thus a proper analysis of the avifauna of Mexico involves at least a "bird's-eye" glance at the whole New World.

c) Historical

1. The weight of evidence and authority is against the arrival of any terrestrial order of birds in the New World by any early "southern" route. (Simpson, 1940)

2. The origin of modern orders of birds somewhere in the Northern Hemisphere in Eocene (chiefly) time is clearly proved by the fossil record. In North America alone there is a fossil record for 14 orders and 27 families in Eocene and Miocene deposits, and this number could be considerably extended by adding those from the Old World. (Wetmore, 1940; Romer, 1946)

3. The sad lack of avian Tertiary fossils from South America has no value as negative evidence. The assumption that there were few birds in South America during early Tertiary time is too ridiculous to merit discussion. As birds developed a little earlier than mammals, there must have been a rich and varied avifauna in South America, just as we know there was for mammals.

4. An analysis of modern birds in South America makes it impossible to divide them into two clear groups, old and relatively recent, as is so readily demonstrable in mammals. There are two obvious factors making for reconciliation, (1) the extreme adaptability of birds to varying climates and habitats. (2) their extreme motility and proclivity to wander, thus greatly reducing the effect of the Central American Tertiary water-gaps.

5. It follows, therefore, that most orders of living birds are Old Northern in origin, and the great majority of families now present in the New World (79). The maximum possible number of South American families inferentially autochthonous, as well as endemic, is 22, and I hazard the guess that palaeontological discovery will reduce this number in the future, just as it has in the past. I venture to predict that many of the fossil birds to be discovered in the early Tertiary formations of South America will prove to belong to strange orders and families, now extinct, just as with mammals; but that the

percentage assignable to modern families may run higher than in mammals. These 22 families of birds represent Dunn's South American fauna; an unknown number of genera and species of at least fourteen of these families reached Mexico and Central America prior to the period of Pleistocene glaciation; some of them survived as relicts in Mexico and the mountains of Central America; a still smaller number have been moving northward with the return of warmer climates and the recent northward march of humid tropical forests.

6. The modern Holarctic fauna of Dunn contains three special families, the loons, alcids and phalaropes, and many genera and species, most of which reach Mexico only as winter visitants. These three special families furnish an ideal illustration of the clash between the descriptive facts of present distribution and their history. The first two have a history which goes back to Eocene deposits in parts of Europe and the United States, which most certainly did not enjoy the boreal-arctic climates, to which the loons and alcids are now confined in the breeding season. It can consequently be argued that their existence in this climate is a recent adaptation, and they have just as much right to be thought of as Old Northern as any other family.

7. The refrigeration of climate in the Northern Hemisphere, which began in late Pliocene time and culminated in the Ice Age, initiated a period of wholesale southward migration and extinction. Group after group of Old Northern families and genera must have passed south through Mexico, leaving some members behind, on their way to tropical America, where the majority of living members now only survive. I suggest that a substantial number of the endemic genera and species of present day Mexico originated from this late Pliocene migration.

8. During the maximum period of refrigeration of climate, the South American element was virtually destroyed in Mexico, and the modern Boreal element along with members of Old World families of recent arrival in the New World passed through Mexico in turn, and penetrated to southern South America. Aggressive and adaptable types like *Zonotrichia capensis* and *Parula pitiayumi* are now widely distributed throughout. Others survive as relicts, like the *Aimophila* sparrow and the little *Dendrocopos* woodpecker in temperate South America, the *Dendrocopos* in the mountain cloud forests of western Panama, the Crossbill and the Creeper in the upper tropical pine forests of Nicaragua.

9. Further than this we cannot safely go. While Warm and Middle North America are valid zoogeographic concepts as far as modern birds are concerned, the Old Northern families of birds in Dunn's

sense cannot be divided into two groups. In the first place the fossil record is inadequate; in the second place there is the matter of climate in the historical sense; we are assured that formerly Middle North America enjoyed an even warmer climate than that of Warm North America today.

10. As is only natural and proper in an historical summary, we have reached Mexico and its modern bird-life last. In a geographic and historical sense Mexico has always existed. For 150 million years it has been available for colonization by birds, always directly from the north, never seriously unreachable from the south. Thanks to its varied topography, innumerable climates and habitats, it has proved to be one of the major areas for secondary evolution of birds in the New World, and a last haven for relict or hard pressed species. Hence its comparatively enormous avifauna, with a high percentage of endemics, in a world the bird-life of which was terribly impoverished by the Ice-Age.

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# NEW AND LITTLE KNOWN CARTILAGINOUS FISHES FROM THE ATLANTIC

BY HENRY B. BIGELOW and WILLIAM C. SCHROEDER

WITH SEVEN PLATES

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No. 7 — *New and little known Cartilaginous Fishes from the Atlantic*[1]

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With Seven Plates

## Batoidei

## Family RAJIDAE

### Skates

The rajid fauna of shoal water off eastern North America may be regarded as fairly well known so far as the identity of its constituent species is concerned. But the recent discovery along the 200–500 fathom zone off Cuba and in the Gulf of Mexico of an abundant population of small skates, the existence of which had not been suspected previously, shows that we have much to learn of the skates that exist in depths greater than 200 fathoms or so in the western North Atlantic. Descriptions of three of these species, representing two new genera *Breviraja* and *Cruriraja*, have already appeared (Bigelow and Schroeder, 1948). Here we describe and picture five more new species of *Breviraja* and two new deep water species of the old genus *Raja*.

### Genus Raja Linnæus, 1758

#### Raja jenseni spec. nov.

Plate 1

*Type Specimen.* Female 541 mm. long, continental slope off southern New England, Lat. 39°35′N., Long. 71°21′W., 1043 fathoms, U. S. National Museum, No. 35592.

*Additional Material.* Male 223 mm. long, Lat. 41°09′N., Long. 66°02′W., 1255 fathoms, U. S. National Museum, No. 33457; and female about 850 mm. long, in very fragmentary condition, upper part of continental slope off Halifax, Nova Scotia, about 200 fathoms, U. S. National Museum, No. 23483. This last specimen, caught from the fishing schooner AUGUSTA H. JOHNSTON, Captain G. A. Johnston, is catalogued as from Lat. 42°37′N., Long. 62°55′W. But

[1] Contribution No. 511 from the Woods Hole Oceanographic Institution.

the depth at which it was taken locates it as from closer in shore and a few miles farther north.

*Diagnostic Characters.* This skate resembles *R. hyperborea* Collett, 1878, so closely that it might easily be mistaken for the latter. It is set apart from *hyperborea* sharply by having 56–66 series of teeth (only 38–44 in *hyperborea*) and by lacking thorns on the anterior margins and mid-posterior parts of the pectorals and either side of the mid-dorsal line on the disc rearward from the nuchal region.

*Description.* Disc about 1.35 times as wide as long, maximum anterior angle to level of spiracles 90°; tip of snout rounded, not noticeably projecting; anterior margins nearly straight except slightly convex opposite orbits, general contour thus broadly wedge-shaped; outer and posterior corners both rather abruptly rounded; posterior margins nearly straight; axis of greatest breadth about 73 per cent of distance rearward from tip of snout toward level of axils of pectorals. Tail from center of cloaca about 63 per cent as long to first dorsal and about 90 per cent as long to tip as from center of cloaca to tip of snout.

A few small thorns along rostral ridge, one larger close in front of each orbit; one close behind orbit and one inward-rearward from each spiracle; three large on each scapular region arranged thus ∴; also a median row of 24 or 25 conspicuous thorns on radiate bases, from nuchal region to first dorsal fin, 7 of them anterior to level of axils of pectorals, largest on disc, successively smaller along rear part of tail. Skin of disc also prickly (in addition to the larger thorns) on snout, between orbits, above eyes, in advance of scapular regions, over greater part of pectorals, and along posterior part of mid-dorsal belt; but naked along either side of latter and around posterior margins of pectorals. Pelvics with a few prickles on inner parts but without thorns (more or less thorny on *R. hyperborea*). First and second dorsals with a few minute prickles. Each side of tail with a densely prickly band from base to tip. Lower surface smooth on disc and tail.

Evidently the thorns on the disc decrease somewhat in number and in relative size with growth, for the juvenile male, 223 mm. long, is more thorny along the rostral ridge; it has several smaller thorns around the anterior and inner margins of each orbit, in addition to the two larger ones that persist there on the type specimen, also 4 thorns on each scapular region (only 3 on the type) and 31 in the mid-dorsal row, nuchal region to first dorsal. The disc also is more uniformly prickly on small specimens than on larger, with only a narrow naked band around the posterior margins of the pectorals; and the pelvics are more prickly on their inner parts.

Snout in front of orbits about 2.3 times as long as distance between orbits; its length in front of mouth about 1.3 times as great as distance

between exposed nostrils. Orbit about 72 per cent as long as distance between orbits and about 1.8 times as long as spiracle. Nasal curtain fringed; expanded outer posterior margin of nostril smooth. Mouth very little arched. Teeth in about 66 series above, with sharp cusp, loosely spaced in transverse rows. Distance between inner ends of fifth gill openings about 1.1 times as great as between exposed nostrils. First and second dorsal fins about alike in size and shape and separated by a very short interspace without thorns. Pelvics deeply concave; anterior margin only about 47 per cent as long as from pelvic origin to rear tips; anterior lobe narrowly rounded; posterior lobe moderately convex outwardly, the rear tip abrupt, extending back about 40 per cent of distance from level of axils of pectorals toward first dorsal.

Upper surface (after many years in alcohol) plain light grayish brown, a little darker along margins of fins; lower surface brownish gray, dusky around cloaca and on inner parts of pelvics.

The largest specimen so far seen (a female) is about 850 mm. long, suggesting that the maximum size is about the same as for *R. hyperborea*.

*Remarks.* Accounts of the largest of the three specimens listed above have already appeared, by Jensen (1914, p. 31), and by us (1927, p. 246; 1934, p. 29), under the name *R. granulata* Goode and Bean, 1879. But it seems practically certain, from the original account (Goode and Bean, 1879, p. 28) and from the subsequent illustration (Goode and Bean, 1895, pl. 9, fig. 30) of the type specimen of *granulata* that the latter is a synonym of *R. laevis* Mitchill, 1817. A new name is therefore needed for the skate described here. We propose *jenseni* in recognition of Dr. A. S. Jensen's contributions to the ichthyology of the North Atlantic.

The largest of the three specimens listed above (Study Material, p. 385) was earlier characterized by us (Bigelow and Schroeder, 1927, p. 246; 1934, p. 29) as with minute rounded tubercles on the lower surface. Renewed examination, however, has shown that Jensen's (1914, p. 32, footnote 2) account of it as smooth below was correct. The supposed tubercles (no longer to be seen or felt) doubtless were nothing more than grains of sand embedded in the coagulated mucous with which the skin of the lower surface is coated.

*Habits.* The localities and depths of capture indicate that this is a deep water species, finding its upper limit at about 200 fathoms, else fishermen would almost certainly pick it up along the upper slopes of the banks. The nature of its teeth suggests that it feeds on small fishes and free swimming crustacea, just as its relative *R. hyperborea* is known to do.

RAJA MOLLIS spec. nov.

Plate 2

*Type Specimen.* Juvenile male 262 mm. long, continental slope south of southern Nova Scotia, Lat. 41°53′N., Long. 65°35′W., 858 fathoms, ALBATROSS Station 2072, September 2, 1883; U. S. National Museum, No. 33385.

*Diagnostic Characters. R. mollis* resembles *R. spinicauda* Jensen, 1914 and females and juvenile males of *R. senta* Garman 1885, most nearly among skates of the North Atlantic in its general form, and in the fact that the upper surface of its disc and its entire tail are uniformly prickly. But it differs noticeably from *R. senta* in lacking any large thorns on its disc posterior to its scapular region. The lack of large thorns on its tail, with the greater length and uniformly prickly lower surface of the latter set it apart from *R. spinicauda.* And it appears to be unique among skates of the genera *Raja* and *Breviraja* so far known from the Atlantic in the softness of the rostral projection from its cranium. In this respect it appears to parallel *Raja abyssicola* Gilbert, 1895, from deep water off the coast of British Columbia, and *R. stellulata* Jordan and Gilbert, 1880, southern California to Alaska. But each of these has a mid-dorsal row of thorns on the tail and disc which *R. mollis* lacks.

*Description of Type.* Proportional dimensions in per cent of total length.

*Disc:* extreme breadth 61.0; length 49.7.
*Snout length of:* in front of orbits 14.9; in front of mouth 15.7.
*Orbits:* horizontal diameter 3.8; distance between 3.8.
*Spiracles:* length 2.1; distance between 7.1.
*Mouth:* breadth 8.0.
*Exposed nostrils:* distance between inner ends 8.6.
*Gill openings:* lengths 1st 1.5; 3rd 1.5; 5th 1.0; distance between inner ends 1st 13.2; 5th 8.8.
*First dorsal fin:* vertical height 2.3; length of base 4.4.
*Second dorsal fin:* vertical height 2.3; length of base 5.0.
*Pelvics:* anterior margin 10.3.
*Distance:* from tip of snout to center of cloaca 42.8; from center of cloaca to 1st dorsal 44.4; to tip of tail 57.2; from rear end of 2nd dorsal to tip of tail 3.4.
*Interspace between:* 1st dorsal and 2nd dorsal 0.0.

Disc about 1.2 times as broad as long, subangular in front; tip of snout slightly blunted, projecting a little; maximum anterior angle in front of spiracles about 115°; anterior margins from close behind tip

of snout either nearly straight or very weakly concave abreast of eye and spiracle;[1] outer corners broadly rounded; posterior margins strongly convex; posterior corners well rounded with curvature continuous to axils of pectorals. Tail with very narrow lateral folds confined to posterior ⅓; distance from center of cloaca about as great to 1st dorsal fin and about 1.3 times as great to tip of tail as from center of cloaca to tip of snout. Distance from axils of pelvics to 1st dorsal a little greater (1.1) than from axils of pelvics to front of orbits.

Upper surface of disc (including skin above eyes) rugose except close along posterior margins, with prickles or minute thornlets, some low conical, others higher but straight, others still higher, their tips very fine, curved rearward in varying degree. One or two somewhat larger thorns close in front of eye on juveniles,[2] perhaps a larger number on adults; 1 blunt thorn a little larger still, inward from each spiracle, 1 in mid-line on nuchal region; 1 on mid-dorsal line over pectoral girdle; 1 smaller on each shoulder (perhaps more there on adults); no other sizeable thorns on disc. Upper surface of tail rough with thornlets a little larger than those on disc, its median line also with an irregular row of somewhat larger thorns scattered from opposite tips of pelvics about ⅓ the distance toward 1st dorsal. Upper surface of pelvics prickly on inner parts of posterior lobe, otherwise smooth. Dorsal fins prickly; caudal membrane with a few prickles; lower surface smooth on disc, pelvics, and root of tail, but remainder of tail close set with small thornlets rearward to level of posterior end of 2nd dorsal, similar to upper surface.

Snout in front of orbits about 3.9 times as long as distance between orbits, its length in front of mouth about 1.8 times as great as between exposed nostrils. Orbit about as long as distance between orbits and about 1.8 times as long as spiracle. Nasal curtain fringed, but edge of expanded posterior (outer) margin of nostril smooth or nearly so. Mouth nearly straight on juvenile male, probably also on females, perhaps more arched on mature males. Teeth about $\frac{56}{54}$; close crowded in quincunx, with low conical cusp, bases about as long antero-posteriorly as broad transversely, those of mature males not yet seen. Distance between inner ends of 1st gill openings about 1.6 times as long as between exposed nostrils, distance between 5th gills about ⅔ (67 per cent) as long as between 1st gills; 1st gills about 1.5 times as long as 5th gills, about 19 per cent as long as breadth of mouth. First and second dorsal fins about equal in size, confluent at base without definite interspace, their shape as shown in Pl. 2. Caudal membrane

[1]The two sides of our specimen differ slightly in this respect.

[2]One such thorn on one side of our specimen, two on the other.

posterior to 2nd dorsal about ¾ (77 per cent) as long as base of 1st dorsal. Pelvics deeply concave outwardly, strongly scalloped around concavity; anterior margin nearly as long (90 per cent) as from pelvic origin to rear tip; anterior lobe rounded at tip; posterior lobe moderately rounded outwardly, its inner margin straight; tip well rounded, extending rearward about 1/4 (27 per cent) of distance from axil of pectoral toward 1st dorsal. Rostral cartilage extending nearly to tip of snout; so soft and flexible as hardly to be felt, but visible against a strong light; tips of anterior rays of pectorals falling a little short of level of tip of rostral cartilage.

Upper surface of disc, tail and pelvics light grayish brown (after many years in alcohol), except pale yellowish either side of rostral ridge, perhaps translucent there in life; no dark markings. Lower surface pale yellowish without markings.

It is not known how large this skate may grow; the only specimen yet seen (a male) is juvenile, its claspers reaching only ⅔ the distance rearward along the inner margins of the pelvics.

*Habits.* The great depth at which the one known specimen was trawled (858 fathoms), added to its absence from the catches of skates that are made along the upper slopes of the fishing banks off Nova Scotia and the Gulf of Maine, mark this as a deep sea species, probably confined to depths greater than 200–300 fathoms.

*Range.* So far known only from the lower part of the continental slope off southern Nova Scotia.

## Genus BREVIRAJA Bigelow and Schroeder, 1948

### BREVIRAJA ATRIPINNA spec. nov.

Plate 3

*Type Specimen.* Female, 278 mm. long, Atlantis Station 3443, Lat. 23°22′N., Long. 79°53′W., 325 fathoms, Museum of Comparative Zoölogy, No. 36370.

*Additional Material.* One male 225 mm. long and one female, 187 mm. long, trawled off Santa Clara Province, north coast of Cuba, 250 and 500 fathoms, by the research vessel ATLANTIS Stations 2985, 3459; in Museum of Comparative Zoölogy.

*Diagnostic Characters.* Among Atlantic skates *B. atripinna* falls with *B. plutonia* (Garman), 1881, with *B. cubensis* and with *B. sinus-mexicanus* (these last two described as new in the present paper) in the great length of its tail, but it is separable from all three of them by its relatively longer rostral cartilage. The larger specimens also

differ conspicuously from *B. sinus-mexicanus* in relatively longer interspace between their first and second dorsal fins. And while very young *atripinna* more nearly agrees with *sinus-mexicanus* in this respect, its tail is so much less thorny that there is little danger of confusing the two. The plain coloration of its disc and tail without dark markings, combined with its sooty black dorsals, is a convenient field mark to distinguish *atripinna* from the *cubensis-plutonia* group, from which it differs further in the greater length of its snout relative to the distance between its eyes and nostrils, in various other proportional dimensions and in its less obtuse anterior angle.

The great length of its tail marks *atripinna* off from all rajids so far known from the Pacific coast of America, except perhaps for *Raja equatorialis* Jordan and Bollman, 1890, from shoal water off Pacific Panama, for which the tail is described as very long and slender and the two dorsal fins as separated by an interspace longer than either fin. But the back of the disc of *atripinna* is closely and uniformly prickly throughout, and the edge of its nasal curtain even, while the back of *equatorialis* is mostly smooth apart from the larger thorns, and the edge of its nasal curtain deeply fringed. For first-hand descriptions of the type and only known specimen of *equatorialis* see Jordan and Bollman, Proc. U. S. Nat. Mus., **12**, 1890: p. 150; Gilbert, Proc. U. S. Nat. Mus., **48**, 1915: p. 308.

*Description of Type.* Proportional dimensions in per cent of total length.

*Disc:* extreme breadth 45.3; length 38.5.
*Snout length of:* in front of orbits 9.7; in front of mouth 12.6.
*Orbits:* horizontal diameter 5.0; distance between 2.7.
*Spiracles:* length 1.9; distance between 6.1.
*Mouth:* breadth 5.0.
*Exposed nostrils:* distance between inner ends 5.9.
*Gill openings:* lengths 1st 1.3; 3rd 1.3; 5th 1.2; distance between inner ends 1st 10.0; 5th 6.1.
*First dorsal fin:* vertical height 1.3; length of base 4.7.
*Second dorsal fin:* vertical height 1.4; length of base 3.6.
*Pelvics:* anterior margin 11.8.
*Distance:* from tip of snout to center of cloaca 35.7; from center of cloaca to 1st dorsal 47.0; to tip of tail 64.3; from rear end of 2nd dorsal to tip of tail 4.0.
*Interspace between:* 1st dorsal and second dorsal 5.0.

Disc about 1.2 times as broad as long; tip of snout pointed; maximum anterior angle to level of spiracles 120°; anterior margins of disc slightly convex in advance of orbits, thence nearly straight to broadly

rounded outer corners; posterior margins and corners broadly rounded; inner margin weakly convex. Tail slender, its lateral folds confined to posterior ⅔, very narrow, widening somewhat rearward. Distance from center of cloaca about 1.3 times as long to first dorsal, about 1.6 times to second dorsal, and about 1.8 times to tip as from cloaca to snout.

Upper surface of disc roughened with small, sharp, closely set prickles except along extreme posterior margins and on tip of snout; skin over eyes densely prickly; bases of many of the prickles colored with pigmented skin. Also inner margin of each orbit rimmed with a row of about 12–13 small thorns from in front of eye to opposite spiracle; 1–2 small thorns inward from spiracle and another in line with them toward mid-line of disc; 3–4 thorns on each scapular region; a median row of 6 from nuchal region to pectoral girdle, followed after a short gap by about 62 more to first dorsal fin, decreasing in size rearward along tail and in regularity of spacing; also a lateral row along either side of mid-dorsal ridge on posterior part of disc, losing identity rearward among prickles of tail and another row low down along either side of tail from level of axils of pelvics to first dorsal fin. Anterior ⅔ of first and second dorsals prickly; space between dorsals prickly but without larger thorns, caudal membrane naked. Anterior lobe of pelvics naked; posterior lobe densely prickly except at margin. Lower surface smooth on disc and pelvics, but rough with small, close set prickles throughout entire length of tail, except for naked area in median zone along anterior part.

Snout in front of orbits about 2 times as long as orbit; its length in front of mouth about 2 times as long as distance between exposed nostrils. Orbit twice as long as distance between orbits and 2.7 times as long as spiracle. Nasal curtain smooth edged, expanded outer posterior margin of nostril with a few lobelets or irregularities. Mouth arched forward a little centrally. Teeth about $\frac{40}{40}$, close set in transverse series, with low conical cusp.

Distance between 5th gills about as great as between exposed nostrils; base of first dorsal about 1.3 times as long as base of second dorsal; interspace between first and second dorsals about 1.1 times as long as base of first dorsal; caudal posterior to second dorsal about as long as base of second dorsal. Pelvics deeply concave; anterior margin about 90 per cent as long as from pelvic origin to rear tips; anterior lobe slender, bent rearward at outer joint with 2 slender radials in addition to the first stout one of 3 segments; posterior lobe with slightly wavy outer margin; the rear corner rather broadly rounded, extending about ¼ the distance from level of axils of pectorals toward first dorsal; inner margin straight.

Firm rostral process narrow, extending about 75 per cent the distance from front of cranium toward tip of snout. Anterior radials of pectorals extending forward beyond rostral process almost to level of tip of snout.

Upper surface of disc pale pinkish without distinctive markings; dorsal fins and caudal brownish black, a very conspicuous feature; lateral folds on tail transparent anteriorly, becoming brownish black between second dorsal and tip of tail. Lower surface chocolate, except a whitish translucent area between first gill openings and tip of snout; anterior lobes of pectorals and region over body cavity darkest. Posterior lobe of pelvics whitish; tail pale whitish except for a chocolate blotch on its anterior part.

On an immature male 225 mm. long the distance from center of cloaca is about 1.45 times as great to first dorsal, 1.73 times to second dorsal, and 1.9 times to tip of tail as from cloaca to tip of snout; snout in front of orbits 2.3 times as long as orbit; orbit 1.6 times as long as distance between orbits and 1.9 times as long as spiracle; interspace between first and second dorsals 80 per cent as long as base of first dorsal; anterior margins of pelvics about as long as distance from pelvic origin to rear tips. Only 2 small thorns on each scapular region; prickles sparse on anterior ⅓ of lower side of tail; posterior part of second dorsal smooth. Chocolate color of lower surface is confined to outer parts of pectorals and of anterior lobes of pelvics. On very small specimens (female 187 mm. long) the anterior angle (115°) is a little less obtuse than on larger; the snout relatively longer; its length in front of orbits about 3 times as great as length of orbit, and length in front of mouth 2.7 times as great as between exposed nostrils, but rostral cartilage a little shorter proportionately. Interspace between first and second dorsal fins is shorter (about 0.4 as long as base of first dorsal), but caudal membrane relatively longer (about 1.6 times base of second dorsal); dermal armature is similar to that of larger specimens except fewer (7–8 thorns) around orbit, with only 1 on each scapular region and lower surface of tail naked; also the dorsal fins are whitish, not black as on large specimens, and the lower surface of disc and tail plain whitish without darker markings.

A male 225 mm. long is immature, the tips of the claspers still fall a little short of the rear limits of the pelvics.

The several specimens thus far taken were trawled in 250–500 fathoms and none were taken in the many hauls made at lesser depths. Evidently this is a deep water species. It is known only off the north central coast of Cuba.

### Breviraja cubensis spec. nov.

Plate 4

*Type Specimen.* Male, 210 mm. long, from Lat. 23°20′N., Long. 79°59′W., Atlantis Station 3451; Museum of Comparative Zoölogy, No. 36443.

*Additional Material.* 69 specimens, male and female, 68–221 mm. long trawled off north central Cuba at 235–405 fathoms by the research vessel ATLANTIS Stations 2961, 2983, 2984, 2986, 2987, 2988, 2999, 3432, 3438, 3449, 3451, 3457, 3483, 3485. For precise localities, see Chace, 1940.

*Diagnostic Characters.* This little skate closely resembles *B. plutonia* (Garman) 1881, in general form, and some specimens show much the same color pattern. But the anterior lobes of its pelvic fins are shorter than from pelvic origin to rear tip (as long or longer on *plutonia*); the thorns on its disc are smaller and less conspicuous with (usually) only 1 or 2 on each scapular region (3–4 on *plutonia*); its first and second dorsal fins usually are separated by a definite interspace (confluent on *plutonia*); and its rostral cartilage is longer than in *plutonia*, though intermediates may occur in this respect.

*Description of Type.* Proportional dimensions in per cent of total length.

*Disc:* extreme breadth 49.7; length 39.0.
*Snout length of:* in front of orbits 10.0; in front of mouth 11.0.
*Orbits:* horizontal diameter 4.8; distance between 2.9.
*Spiracles:* length 2.4; distance between 7.1.
*Mouth:* breadth 6.2.
*Exposed nostrils:* distance between inner ends 5.0.
*Gill openings:* lengths 1st 1.2; 3rd 1.2; 5th 1.0; distance between inner ends 1st 11.0; 5th 6.7.
*First dorsal fin:* vertical height 1.2; length of base 5.2.
*Second dorsal fin:* vertical height 1.7; length of base 3.8.
*Pelvics:* anterior margin 11.2.
*Distance:* from tip of snout to center of cloaca 38.1; from center of cloaca to 1st dorsal 50.0; to tip of tail 61.9; from rear end of 2nd dorsal to tip of tail 1.4.
*Interspace between:* 1st dorsal and 2nd dorsal 1.4.

Disc 1.2 times as broad as long, tip of snout forming a low projection; maximum anterior angle to level of spiracles 120°; anterior margins convex before orbit and approaching outer corner, weakly concave between; outer corner and posterior margin broadly rounded; inner margin weakly convex. Tail with narrow lateral folds along posterior ⅓ to tip, widening rearward; distance from center of cloaca

1.3 times as great to first dorsal, 1.5 times to second dorsal and 1.6 times to tip of tail as from cloaca to tip of snout.

Upper surface of disc, including skin above eyes mostly covered with very small close set prickles; anterior and posterior margins only sparsely prickly or smooth; tip of snout smooth, also areas outward-rearward from scapular regions. Upper surface of tail, including interspace between first and second dorsals roughened with scattered prickles besides thorns described below. Ten small thorns around inner margin of orbit on one side, 11 on the other; 1 inward rearward from each spiracle; 2 on each scapular region; a median row of 72 from nuchal region along disc and tail to first dorsal fin, 19 of these anterior to level of axils of pectorals; those on tail sharper than those on disc. Each side of tail from a little posterior to axils of pectorals with 1 additional row (2 such rows locally) to level of first dorsal, the linear arrangement less regular rearward. Anterior parts of first and second dorsals prickly. Pelvics smooth except for a few prickles on inner parts. Lower surface smooth. Sexual armature a patch of thorns on each side of head outward-forward from orbit, near outer margin; also 1–2 irregular rows of alar spines, 4–5 spines per row.

Snout in front of orbit about 2.1 times as long as orbit, its length in front of mouth about 2.2 times as long as between exposed nostrils; orbit about 1.7 times as long as distance between orbits and about 2 times as long as spiracle. Nasal curtain smooth edged, expanded outer posterior margin of nostril also smooth. Mouth weakly bowed centrally. Teeth in about 42 series in upper jaw, with long, sharp recurved cusp, in quincunx. Distance between inner ends of 5th gills about 1.4 times as long as between exposed nostrils. First dorsal fin a little longer than second dorsal; interspace between first and second dorsals about 27 per cent as long as base of first dorsal; caudal membrane posterior to second dorsal about 40 per cent as long as base of second dorsal. Pelvics deeply notched, scalloped around the concavity; anterior margin about 70 per cent as long as from pelvic origin to rear tip. Anterior lobe slender, tapering to narrow tip, of 2 slender radials besides first stout one of 3 segments; posterior lobe moderately convex outwardly, the rear tip narrowly rounded, extending nearly ¼ the distance from level of axils of pectorals toward first dorsal; inner margin straight. Claspers slender, reaching back about ¼ way from tips of pelvics toward first dorsal; without projecting terminal armature when not in function.

Rostral process narrowly triangular, extending about 60 per cent of distance from front of cranium toward tip of snout; pectoral rays reaching nearly to level of tip of snout.

Upper surface of disc pale brownish with a few small roundish

darker brown spots and larger irregular blotches, one, largest, about central on each pectoral. Anterior lobe of pelvics whitish, posterior lobes of same brownish tint as disc, with a few darker markings. Tail with 5 blackish brown cross bars, the fourth and fifth noticeably darker than the others, covering anterior ⅔ of first and second dorsal fins; also a fainter bar opposite tips of pelvics. Lower surface pale yellowish without dark markings.

Among other specimens, half grown to mature, the anterior margins vary from nearly straight to rather strongly sinuous (Fig. 4); the anterior angle ranges up to 138°; snout in front of orbit is 1.6–2.1 times as long as orbit; snout in front of mouth 2.1–2.6 times as long as distance between exposed nostrils; distance between fifth gills 1.1–1.6 times as long as between nostrils; and distance from center of cloaca is up to 1.4 times as great to first dorsal and up to 1.8 times to tip of tail as from cloaca to tip of snout. Some specimens have a detached thorn inward from each spiracle, but others lack this. The maximum number of thorns along the inner margin of orbit among specimens examined is 15, the row spaced regularly on some, but interrupted opposite middle of eyes on others. There may be either 1 or 2 small thorns on each scapular region and from 50 to 100 or more in the mid series which is interrupted on some specimens between pectoral and pelvic girdles. The interspace between the dorsal fins ranges from none up to nearly as long as base of first dorsal. The teeth are in 34–48 series; those of females with low conical cusp, more or less worn down.

The number of cross bars on the tail varies from 4 to 6, and the color pattern is more strongly contrasting on some small specimens (68–100 mm. long) than on larger, usually with a curved bar extending from close behind each orbit to the corresponding scapular region.

Evidently this is a small species, probably not growing to a greater length than 250–300 mm. for the claspers are well developed on a male 221 mm. long.

Nothing is known of its habits other than that it is a deep water species, all so far taken in 235–405 fathoms (325–740 meters). It is so far known only from off the north central coast of Cuba, at the stations listed above.

### Breviraja sinus-mexicanus spec. nov.

Plate 5

*Type Specimen.* Female, 228 mm. long, Lat. 28°34′N., Long. 86°48′W., Albatross Station 2396, U. S. Nat. Mus., No. 103376.

*Additional Material.* Three females and 6 males, 171–325 mm. long from the northeastern part of the Gulf of Mexico between the offings of Pensacola, Florida and of the Mississippi River delta, in U. S. National Museum.

*Diagnostic Characters.* The shortness of its rostral cartilage separates *B. sinus-mexicanus* from all hard nosed skates of the genus *Raja*. Within its own genus it falls with *B. plutonia* Garman, 1881, in the great length of its tail; also in this same respect with *B. atripinna* and *B. cubensis* which are described here as new. But its tail is so much more thorny than that of the *cubensis-plutonia* group that there is no danger of confusing it with either of these, while its anterior angle is less obtuse. It is distinguishable from young *atripinna* by the thorniness of its tail; from older *atripinna* by the shortness of the interspace between its two dorsal fins. Rajids from other oceans that rival or surpass it in length of tail are, *Cruriraja parcomaculata* (Bonde and Swart), 1924, South Africa; *Raja andamanica* Lloyd, 1909, Indian Ocean; *Raja caudispinosa* Bonde and Swart, 1924, (including *R. albalinea* Bonde and Swart, 1924) South Africa; *Raja tobae* Tanaka, 1916, 1927, Japan; and perhaps *Raja equatorialis* Jordan and Bollman, 1890, Panama Bay. But the nature of the pelvics, with separate limb-like anterior subdivision clearly locates *parcomaculata* in the newly described genus *Cruriraja* Bigelow and Schroeder, 1948. This may also prove to be true of *andamanica*, and in any case *sinus-mexicanus* is separable from it by the considerably more broadly rounded outer corners of the disc, by more numerous thorns, and by coloration, *andamanica* being plain slaty below as well as above. *Sinus-mexicanus* more nearly resembles *caudispinosa* in shape of disc and in distribution of thorns, but differs from it in uniformly prickly disc (largely smooth apart from the thorns in *caudispinosa*) and in relatively longer tail. It differs from *tobae* in the facts that its orbit is rimmed with thorns anteriorly as well as posteriorly; that its eyes are much larger than its spiracles (spiracles larger than eyes in *tobae*) and that there are several rows of thorns along its tail (1 row only mentioned for *tobae*). A prickly and thornier disc with the fact that it has only a short interspace between its first and second dorsal fins, if any, sets it apart from *equatorialis*.[1]

*Description of Type.* Proportional dimensions in per cent of total length.

[1]For redescription of the type (and only known) specimen of *equatorialis*, see Gilbert, 1915:309.

*Disc:* extreme breadth 44.7; length 39.4.
*Snout length of:* in front of orbits 9.4; in front of mouth 11.4.
*Orbits:* horizontal diameter 3.5; distance between 2.6.
*Spiracles:* length 2.2; distance between 5.9.
*Mouth:* breadth 4.6.
*Exposed nostrils:* distance between inner ends 4.6.
*Gill openings:* lengths 1st 0.9; 3rd 0.9; 5th 0.8; distance between inner ends 1st 11.0; 5th 6.2.
*First dorsal fin:* vertical height 1.3; length of base 3.5.
*Second dorsal fin:* vertical height 1.3; length of base 2.6.
*Pelvics:* anterior margin 10.5.
*Distance:* from tip of snout to center of cloaca 32.9; from center of cloaca to 1st dorsal 54.8; to tip of tail 67.1; from rear end of 2nd dorsal to tip of tail 4.6 (estimated).
*Interspace between:* 1st and 2nd dorsal 0.9.

Disc 1.14 times as broad as long; snout narrow, not noticeably projecting; maximum anterior angle to level of spiracle 110°; anterior margins very slightly concave close posterior to tip of snout, thence nearly straight to broadly rounded outer corners; posterior margins rather strongly convex, rear corners evenly rounded, inner margins nearly straight. Tail with very narrow folds originating close behind tips of pelvics, extending to tip, widening rearward. Distance from center of cloaca 1.66 times as great to origin of first dorsal as from cloaca to tip of snout; tip of tail lost.

Upper surface of disc with 1 small thorn and 1 larger over anterior end of rostral cartilage about ⅓ the way from tip of snout toward orbits; 4 around anterior margin of orbit, 3 or 4 along inner posterior margin to level of spiracle, 1 (larger) inward from spiracle toward median line and several scattered outward from orbits; 4 thorns on each scapular region arranged thus . : .; midline of back with a row of 14 from nuchal region to level of axils of pectorals, irregularly alternating larger and smaller, and about 50 (counting is difficult) along midline of tail to first dorsal, less regularly arranged rearward; also an additional row each side of median row from about midway between pectoral girdle and pelvic girdle to first dorsal, and 1–2 such lateral rows along posterior part of tail, the lowest row continuing to below base of second dorsal. Interspace between first and second dorsals with 1 thorn. In addition to larger and smaller thorns, the upper surface of the disc, out to extreme margins (including skin above eyes and areas either side of rostral cartilage) is sprinkled with very slender prickles entirely enclosed in skin (except if worn off as seems to happen easily) freely movable at base, not rigid as in many species. Posterior lobes of pelvics with a few similar prickles, also

anterior ¼ of upper surface of tail; first and second dorsals with a few slender, sharp spinelets along outer edge.

Lower surface smooth except with a few small rigid prickles on anterior part of tail back to a little beyond tips of pelvics.

Snout in front of orbits about 2.7 times as long as orbit, its length in front of mouth about 2.5 times as great as between exposed nostrils; orbit 1.3 times as long as distance between orbits, about 1.6 times as long as spiracle. Nasal curtain coarsely fringed, expanded margin of nostrils somewhat more finely so. Mouth very weakly arched centrally. Distance between fifth gill openings about 1.3 times as long as between exposed nostrils. Teeth $\frac{46}{46}$, in quincunx, most of those near center with a low, blunt conical cusp. Base of first dorsal about 1.33 times as long as base of second dorsal; interspace between first and second dorsals about ¼ as long as base of first dorsal; caudal membrane lost. Pelvics deeply concave; anterior margin a little more than 4/5 as long as distance from pelvic origin to rear tip; anterior lobe pointed, scalloped along posterior margin, including 4 radials besides the first stout one; posterior lobes strongly convex, inner margins nearly straight, rear tips abrupt, reaching back about 1/5 the distance from level of axils of pectorals toward first dorsal.

Rostral cartilage narrowly triangular, extending about ⅔ the distance from front of cranium toward tip of snout.

Upper surface of disc and tail light purplish brown, palest along margins of pectorals, either side of rostral cartilage and on pelvics; irregularly marked with small darker vaguely outlined spots or blotches, most conspicuous being one either side close to base of tail. Skin covering many of the movable prickles much more deeply pigmented, producing a dark-speckled effect over disc generally. Lower surface plain yellowish white, but with darker hue of upper surface showing through along outer edges of pectorals.

On a small female, nasal curtain and margin of nostril are only partly fringed; teeth are only $\frac{42}{42}$; only 2 thorns on each scapular region, 9 in median row from nuchal region to level of axils of pectorals, with about 36 along tail to first dorsal, and very few prickles have yet appeared on tail and on dorsals, though roughening the disc much as on larger specimens.

On males at maturity the anterior margins of the disc are rather noticeably concave at level of spiracles; the thorns of the lateral rows on the disc are smaller than on the females, the malar regions are more thorny, and the outer corners of the pectorals are strewn with small thorns (lacking on the females), but the pelvics are entirely smooth. The alar spines are in 2 rows, 4–7 spines per row; the claspers slender, widening a little at tip, reaching rearward about 3/10 the distance

from level of axils of pelvics toward tip of tail; no terminal spines or hooks exposed when not in function. Mature males are similar to females in general hue but without conspicuous markings, and only occasional prickles are densely pigmented, here and there.

The state of development of the claspers shows that males mature at a length of 310–330 mm., probably the females also.

So far only known from 170–347 fathoms, off the north and northeastern coast of the Gulf of Mexico, Lat. 28°34′N., Long. 86°48′W., ALBATROSS Station 2396; Lat. 28°36′N., Long. 86°50′W., ALBATROSS Station 2395; Lat. 28°45′N., Long. 86°26′W., ALBATROSS Station 2398; Lat. 29°08′N., Long. 88°08′W., ALBATROSS Station 2377; and a recent record from Lat. 29°02′N., Long. 88°40′W.

### Breviraja spinosa spec. nov.

Plate 6

*Type Specimen.* Female 288 mm. long from Lat. 30°58′N., Long. 79°34′W., 250–290 fathoms, collected by research vessel ATLANTIS, Museum of Comparative Zoölogy, No. 36373.

*Additional Material.* Female, 280 mm. long, off middle Florida, Lat. 29°41′N., Long. 79°55′W., 373 fathoms, ALBATROSS Station 2664, in U. S. National Museum; also a female 187 mm. long, off north Florida, Lat. 30°21′N., Long. 79°55′W.

*Diagnostic Characters.* This new skate resembles *Raja fyllae* Lutkin, 1887, in general appearance, including the arrangement of its thorns, but the shortness of its rostral cartilage marks it off sharply from *fyllae*. The presence of 3 or 4 irregular rows of large and conspicuous thorns along the mid belt of its disc separates it from all other western Atlantic members of its own genus. And it differs in the combination of a broadly rounded anterior contour with a conspicuously thorny mid belt (including shoulder region) from any rajid with a short rostral cartilage yet described from Pacific-American waters.

*Description of Type.* Proportional dimensions in per cent of total length.

*Disc:* extreme breadth 50.8; length 42.8.
*Snout length of:* in front of orbits 8.0; in front of mouth 10.2.
*Orbits:* horizontal diameter 4.8; distance between 3.6.
*Spiracles:* length 3.4; distance between 7.0.
*Mouth:* breadth 7.8.
*Exposed nostrils:* distance between inner ends 6.0.
*Gill openings:* lengths 1st 1.4; 3rd 1.4; 5th 1.2; distance between inner ends 1st 15.9; 5th 7.9.

*First dorsal fin:* vertical height 1.4; length of base 5.8.
*Second dorsal fin:* vertical height 1.5; length of base 5.5.
*Pelvics:* anterior margin 11.6.
*Distance:* from tip of snout to center of cloaca 42.3; from center of cloaca to 1st dorsal 45.8; to tip of tail 57.7; from rear end of 2nd dorsal to tip of tail 2.0.
*Interspace between:* 1st dorsal and 2nd dorsal 0.0.

Disc obtusely rounded in front; tip of snout marked by a low papilla; maximum anterior angle to level of spiracles 142°; anterior margins convex anterior to level of orbits, thence nearly straight to very broadly rounded outer corners, the contour a continuing arc around convex posterior margin and rounded rear corners to axils. Tail moderately robust with narrow lateral folds along posterior ⅓ nearly to tip; distance from center of cloaca about 1.1 times as great to first dorsal fin and about 1.35 times as great to tip of tail as from cloaca to tip of snout.

Upper surface of disc conspicuously rough; medium sized thorns scattered along rostral ridge, about 10 around anterior-inner margin of orbits, and 1 larger inward from each spiracle; malar regions outward from eyes and spiracles with 12–15 large thorns; 2–3 on each scapular region; a band of various sizes (some very large) along mid belt of back from nuchal region rearward, irregularly distributed on disc but partially in serial arrangement (4–5 rows) on tail to first dorsal fin followed by 1–2 rows of smaller thorns along either side of tail to tip; those on disc and some of those on tail with conspicuously radiate bases. Disc, including skin above eyes further roughened by prickles of various sizes except naked above body cavity, around posterior margins of pectorals, and between orbits. Anterior ⅓ of tail also with a band of close set prickles along either side in addition to the thorns; upper anterior parts of dorsals prickly; pelvics smooth. Lower surface smooth except for a few prickles on anterior part of tail along outer edge on one side (none on the other side).

Snout in front of orbits about 1.7 times as long as orbit, its length in front of mouth about 1.6 times as great as distance between exposed nostrils; orbit about 1.3 times as long as distance between orbits, about 1.4 times as long as spiracle. Nasal curtain fringed; expanded outer posterior margin of nostril somewhat irregular. Mouth weakly arched. Teeth $\frac{46}{44}$, close set in quincunx; older rows worn nearly smooth, younger rows with low conical cusp. Distance between fifth gill openings about 1.3 times as long as between exposed nostrils. First and second dorsals confluent, base of first about as long as base of second. Extreme tip of tip of tail missing. Pelvics deeply concave,

weakly scalloped around the indentation; anterior margin about ⅔ as long as from pelvic origin to rear tip; anterior lobe small, with well rounded tip, of 3 radials besides the first stout one. Posterior lobe rather strongly convex outwardly, rear corners abruptly rounded, reaching back a little more than ⅓ the way from level of axils of pectorals toward first dorsal fin.

Rostral cartilage broadly triangular, extending about ½ the distance from front of cranium toward tip of snout.

Upper surface plain light brown, without evident markings. Lower surface whitish, central part of disc, anterior parts of pelvics, and anterior ¼ of tail irregularly blotched with chocolate.

The chief differences between the smallest specimen and the type are such as may be attributed to an early stage in growth. There are only 36 series of teeth; the tail is relatively longer (distance from center of cloaca 1.3 times as great to first dorsal and 1.6 times as great to tip as from center of cloaca to tip of snout); there are only 7 or 8 thorns around each orbit, but the thorns along mid belt of disc are more numerous and more regularly arranged serially in 5–6 rows. The thorns along tail include a definite median row of 25; and the thorns on the malar regions (conspicuous on the type) are foreshadowed by coarse sharp prickles only. The prickles on the disc as a whole are finer and closer set than on the type and involve the area between the orbits, which is not the case on the type; the prickly band on either side of the tail extends along anterior ⅔, and the dorsal fins are more generally prickly. The upper surface (plain colored on the type) is marked on the posterior part of the disc with 2 pairs of whitish spots indistinctly outlined; the outer parts of the dorsals and tip of tail are brownish, the lower surface plain white.

The presence of large thorns on the malar region of a female only 288 mm. long, but not on the youngest specimen, makes it likely that this species matures at a length of perhaps 300 mm.

Nothing is known of its habits except that it is evidently a deep water species. It is known only from the localities listed above, p. 400.

### Breviraja yucatanensis spec. nov.

Plate 7

*Type Specimen.* Juvenile male (the type), 215 mm. long, from northeastern slope of Yucatan, 231 fathoms, U. S. National Museum No. 148273.

*Diagnostic Characters.* This newly discovered species is marked off from all other known members of its genus in the western Atlantic,

excepting for *B. spinosa*, by the presence of 2 or more irregular rows of thorns along the median belt of its disc rearward from the scapular region. And it differs from *B. spinosa* in its less conspicuous thorns; also in the facts that its snout anterior to the orbits is about 3.5 times as long as the distance between the orbits (not more than 2.5 times in *B. spinosa*), that its first and second dorsal fins are separated by a definite (though short) interspace with 1 or 2 thorns, and that the upper surface of its disc is closely freckled with small dark brown dots (not freckled, on *B. spinosa*).

*Description of Type.* Proportional dimensions in per cent of total length.

*Disc:* extreme breadth 55.0; length 45.2.
*Snout length of:* in front of orbits 9.8; in front of mouth 11.6.
*Orbits:* horizontal diameter 4.9; distance between 2.8.
*Spiracles:* length 2.6; distance between 6.5.
*Mouth:* breadth 6.7.
*Exposed nostrils:* distance between inner ends 7.0.
*Gill openings:* lengths 1st 1.4; 3rd 1.9; 5th 1.3; distance between inner ends 1st 13.2; 5th 8.1.
*First dorsal fin:* vertical height 2.3; length of base 5.8.
*Second dorsal fin:* vertical height 2.1; length of base 4.9.
*Pelvics:* anterior margin 12.6.
*Distance:* from tip of snout to center of cloaca 39.5; from center of cloaca to 1st dorsal 44.7; to tip of tail 60.5; from rear end of 2nd dorsal base to tip of tail 3.7.
*Interspace between:* 1st dorsal and 2nd dorsal 1.4.

Disc about 1.2 times as broad as long, moderately obtuse in front, with tip of snout hardly protruding; maximum anterior angle in front of spiracles about 128°; anterior margins weakly convex from tip of snout to level of eyes, very slightly concave at level of spiracles and straight thence outwardly; outer corners broadly rounded; posterior margins weakly and evenly convex; posterior corners broadly rounded, the curvature continuous to axils of pectorals. Lateral folds on tail extremely narrow, extending along posterior 4/5 nearly to tip. Tail from center of cloaca about 1.1 times as long to 1st dorsal and about 1.5 times as long to tip as from center of cloaca to tip of snout. Distance from axils of pelvics to 1st dorsal about as long (1.1) as from axils of pelvics to fronts of orbits, about 90 per cent as long as from center of cloaca to tip of snout.

A few small thorns on anterior part of rostral ridge; 5–7 along inner anterior margin of orbit;[1] 1–2 on inner margin and a group of about 4

[1]Five on one side, seven on the other on specimen examined.

between inner posterior edge of orbit and inner end of spiracle; about 3 on nuchal region; 2–3 on each shoulder; also 2 rows along mid-dorsal belt on disc from a little behind pectoral girdle rearward, with an occasional thorn between them in the midline. Outer anterior parts of pectorals sparsely strewn with small thorns grading down to prickles; inner parts of pectorals roughened generally with minute prickles, also nuchal region; a few prickles here and there on anterior part of head, also between thorns on shoulders and along mid-dorsal belt; skin over eyes prickly; posterior parts of pectorals smooth. Upper surface of tail with 3–4 irregular rows of thorns along anterior part, about as large as on disc; 2–3 rows rearward to 1st dorsal fin; 1 thorn in interspace between 1st and 2nd dorsals. Each side of tail (from axil of pelvic) with a band of close set prickles along anterior ½, decreasing posteriorly to 1–2 rows interspaced with very small thornlets past 2nd dorsal fin. Dorsal fins and upper surface of pelvics smooth; lower surface smooth everywhere.

Snout in front of orbits about 3.5 times as long as distance between orbits, its length in front of mouth about 1.6 times as great as distance between exposed nostrils; orbit about 1.7 times as long as distance between orbits and about twice as long as spiracle. Nasal curtain fringed, also expanded posterior (outer) margin of nostril. Mouth only a little arched forward in juvenile, probably also in females, perhaps more strongly so in adult males. Teeth in 46 series in upper jaw, those of juvenile males (probably also of females) oval, rounded, without cusp, close set in quincunx; those of mature males not yet seen. Distance between 1st pair of gill openings about 1.9 times as great as between exposed nostrils; between 5th gills about 1.2 times; 1st gills about as long as 5th gills and a little more than 1/5 (21 per cent) as long as breadth of mouth. First and second dorsals about alike in size and shape, anterior margins sloping, weakly convex, posterior margins slightly recurved. Dorsal fins separated by a short but definite interspace with 1 thorn. Caudal membrane posterior to 2nd dorsal about 30 per cent as long as base of 1st dorsal. Pelvics deeply concave outwardly, with 3 conspicuous scallops at base of concavity; anterior margin about 60 per cent as long as from pelvic origin to rear tip; anterior lobe fleshy with rounded tip; posterior lobe weakly and evenly convex outwardly, rear tip narrowly blunted, reaching about ¼ of distance from axils of pectorals toward 1st dorsal fin. Claspers of mature males not yet seen.

Rostral cartilage extends a little more than ⅔ (69–70 per cent) the distance from front of cranium toward tip of snout; anterior radials of pectorals extend nearly to level of tip of snout.

Upper surface (after many years in alcohol) brownish gray; disc

and anterior part of tail thickly freckled with darker brown dots; posterior part of tail with similar dots aggregated in 2 indistinct cross bars, also an additional, more definite dark bar crossing tail and anterior part of each dorsal fin. Caudal membrane sooty; lower surface uniformly pale yellowish.

A male (only specimen yet seen) 118 mm. broad, is juvenile, its claspers reaching only about ½ way on inner margins of pelvics. Size at maturity not known.

The depth of capture (231 fathoms) of the only recorded specimen suggests that this is a deep water species, but nothing definite is known of its habits.

So far known only from northeastern slope off Yucatan, at 231 fathoms.[1]

## Holocephali

### Family RHINOCHIMAERIDAE

The few known members of this curious family of long nosed chimaeroids have commonly been distributed between two genera, *Harriotta* Goode and Bean, 1886, 1895, and *Rhinochimaera* Garman, 1901, the first with ridges and knobs on the dental plates but without denticles along the upper margin of the caudal fin, the second with smooth dental plates but with the upper margin of the caudal fin armed with a conspicuous series of large denticles. Schnakenbeck (1931) on the other hand has united these two genera under the older name *Harriotta* and has referred to it a new species, *pinnata*, with denticulate upper caudal, ridged dental plates, and also with a separate anal fin, which is lacking on all other known Rhinochimaeroids.

The species in the family so far described fall into three categories: *Harriotta raleighana* Goode and Bean, 1895, ridged dental plates, without caudal denticles or anal fin; *Harriotta pacifica* Mitzukuri, 1895, and *Rhinochimaera atlantica* Holt and Byrne, 1909, smooth dental plates, denticulate caudal, no anal fin; and *Harriotta pinnata* Schnakenbeck, 1931, ridged dental plates, denticulate caudal, a separate anal fin. The detailed sculpture of the dental plates may not stand the test of time as a generic character since it not only alters with growth but is known to vary from specimen to specimen in other Chimaeroids. But the presence of large and highly specialized denticles along the upper margin of the caudal fin seems of greater taxonomic importance, since it marks off the two species concerned from all other known chi-

[1]ALBATROSS Station 2359, Lat. 29°19′N., Long. 87°03′W., January 29, 1885.

maeroids. And the presence or absence of an anal fin, separate from the lower lobe of the caudal fin, seems to us well worthy of generic recognition in this family, as it is commonly so considered in the family Chimaeridae. We, therefore, recognize three genera in the family defined as follows:

(1) *Harriotta* Goode and Bean, 1886, 1895; no denticles along upper margin of caudal fin, no separate anal fin, dental plates with ridges and knobs; one known species *H. raleighana* Goode and Bean, 1895, northwestern Atlantic.

(2) *Rhinochimaera* Garman, 1901; upper margin of caudal fin with a series of large denticles, no anal fin, dental plates smooth so far as known; two known species *Rh. pacifica* (Mitsukuri), 1895, Japan, and *Rh. atlantica* Holt and Byrne, 1909, 1910, Irish Atlantic slope.

(3) *Neoharriotta*, new genus; upper margin of caudal fin with denticles, a separate anal fin, dental plates with ridges and knobs; type and only known species, *N. pinnata* (Schnakenbeck), 1931, p. 39, figs. 6–9, Walvish Bay, southwest Africa (type locality); also off Equatorial West Africa, Lat. 2°09′N., Long. 9°27′E., whence we have seen a newly hatched specimen and empty egg case collected by the ATLANTIDE Expedition and loaned us by Dr. Anton F. Bruun.

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PLATES

PLATE 1

## PLATE 1

*Raja jenseni*, sp. nov., female, 541 mm. long, type specimen, continental slope off southern New England, Lat. 39°35′N., Long. 71°21′W., 1043 fathoms (U. S. Nat. Mus., No. 35592). A Upper surface of mid-sector of tail. B Right-hand nostril and nasal curtain of juvenile male, 223 mm. long, eastern slope of Georges Bank, 1255 fathoms (U. S. Nat. Mus., No. 33457), about 1.6 x.

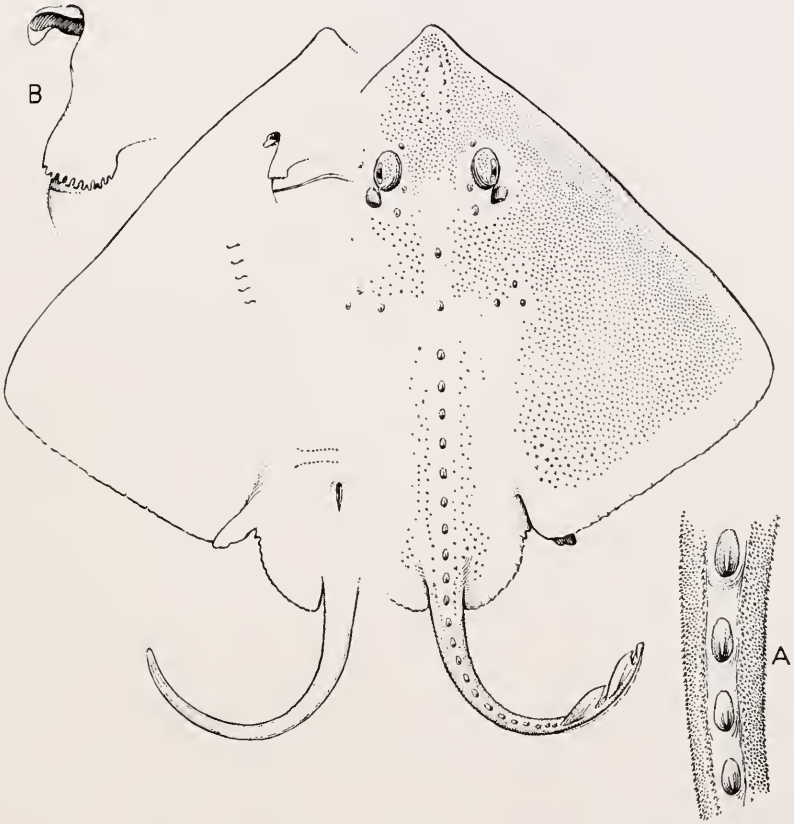
B
A

PLATE 2

## PLATE 2

*Raja mollis*, sp. nov., juvenile male, 262 mm. long, type specimen, continental slope south off southern Nova Scotia, Lat. 41°53′N., Long. 65°35′W., 858 fathoms (U. S. Nat. Mus., No. 33385). A Pelvic fins. B Central part of anterior part of head. C Nasal curtain and nostril, about 2.6 x.

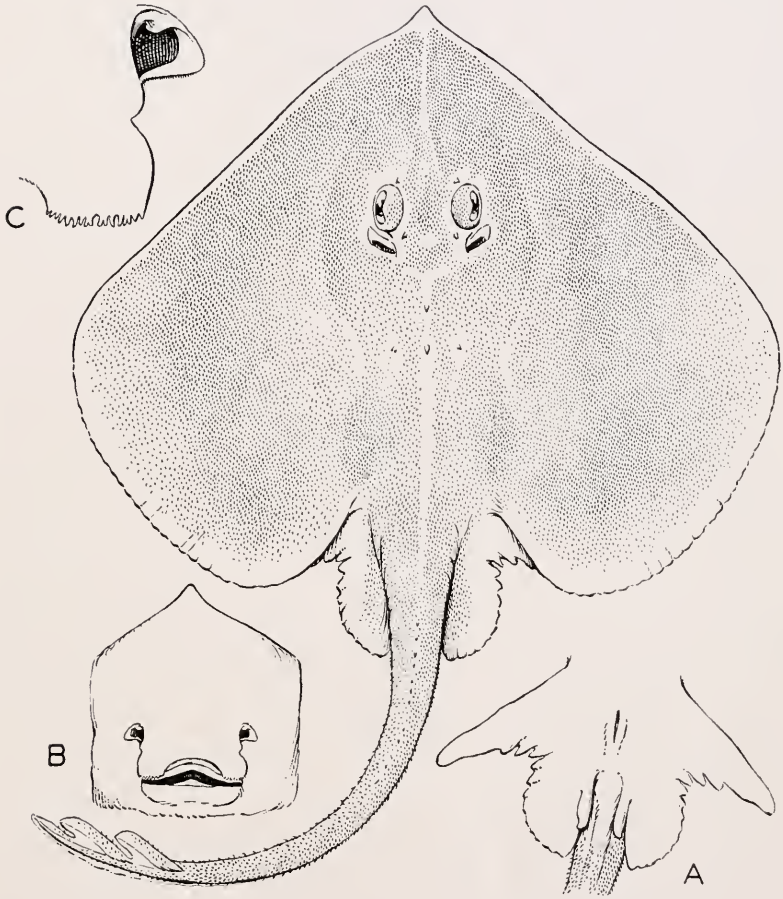
C
B
A

PLATE 3

## PLATE 3

*Breviraja atripinna*, sp. nov., female, 278 mm. long, type specimen, off Santa Clara Province, north coast of Cuba, Lat. 23°22′N., Long. 79°53′W. (Mus. Comp. Zoöl., No. 36370). A Pelvics. B Anterior part of head from below. C Posterior part of tail, about 1.5 x. D Right-hand nostril, about 5.5 x. E Margin of left-hand nasal curtain, about 3.7 x. F Upper teeth.

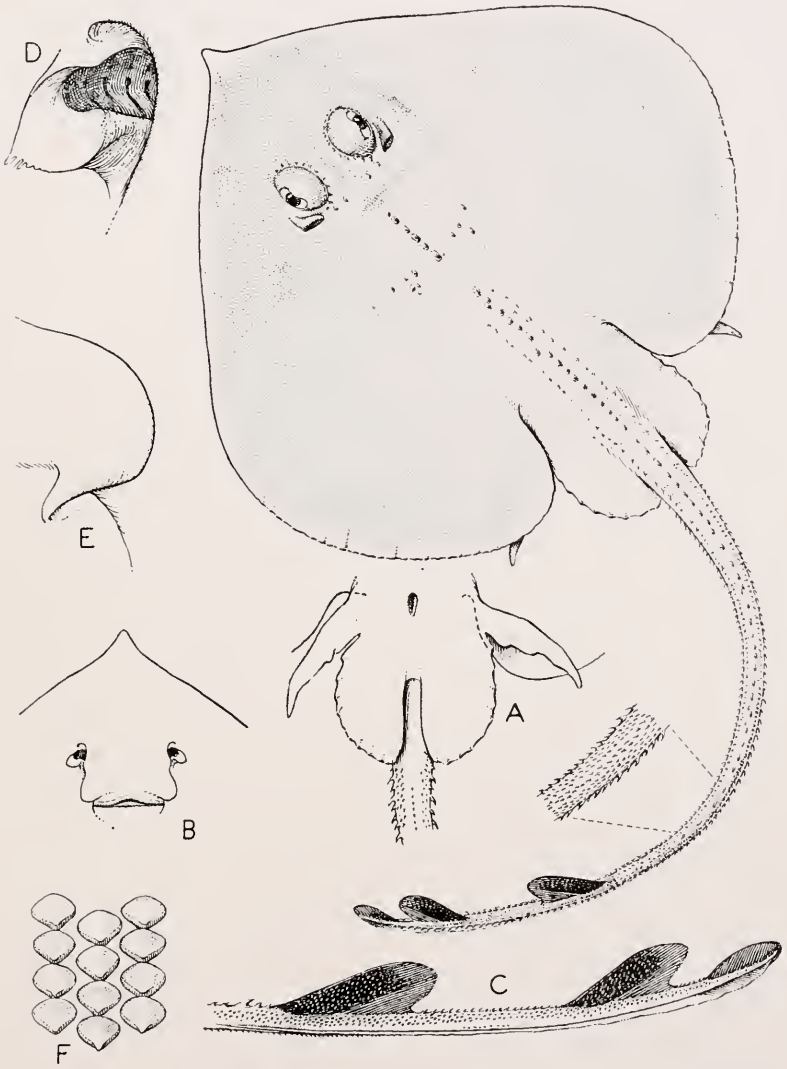
D
E
A
B
C
F

PLATE 4

## PLATE 4

*Breviraja cubensis*, sp. nov. A male, 210 mm. long, type specimen, off Santa Clara Province, north coast of Cuba, Lat. 23°20′N., Long. 79°59′W., ATLANTIS Sta. 3451, 405 fathoms (Mus. Comp. Zoöl., No. 36443). B Lower surface of anterior part of head. C Nostril of same, about 6 x. D Upper teeth of same from near center of jaw, about 9 x. E Female, 202 mm. long, Lat. 23°11′N., Long. 79°08′W., 235–260 fathoms (Mus. Comp. Zoöl., No. 36364). F Upper teeth of same from near center of jaw, about 9 x.

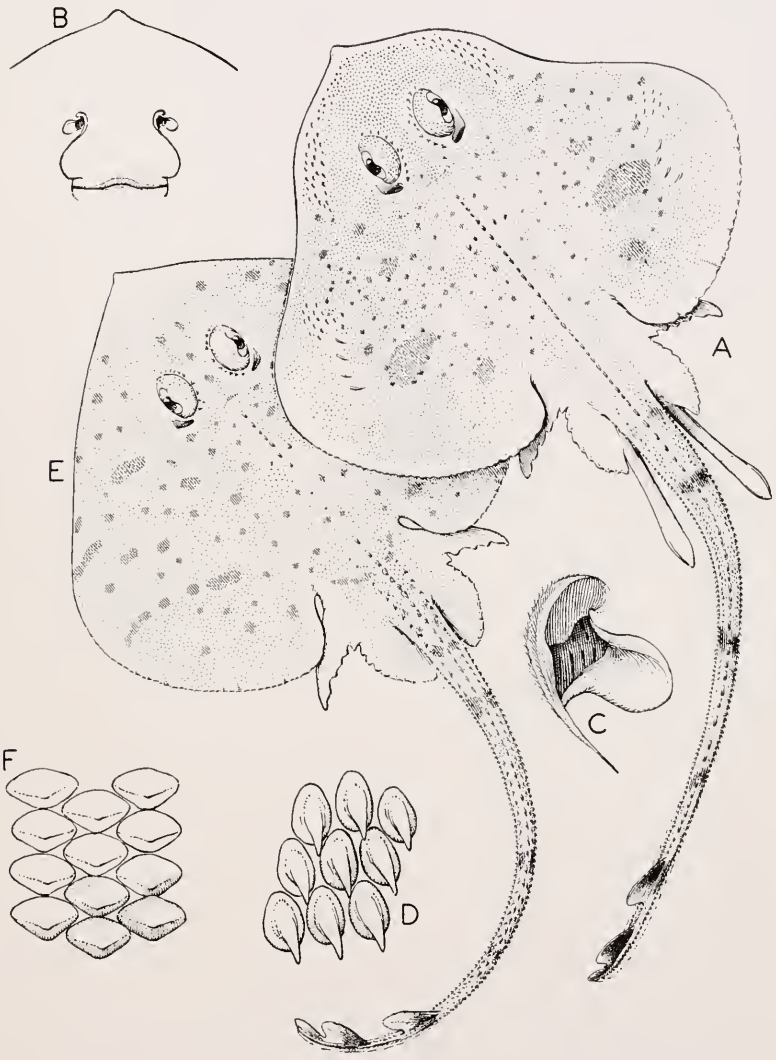
B
A
E
C
F
D

PLATE 5

## PLATE 5

*Breviraja sinus-mexicanus*, sp. nov., female, 228 mm. long, type specimen, off Pensacola, Florida (U. S. Nat. Mus., No. 103376). A Lower side of anterior part of head. B Pelvic fins and base of tail. C Left-hand nostril, about 12 x. D Right-hand nasal curtain, about 10 x. E Upper teeth, about 16 x.

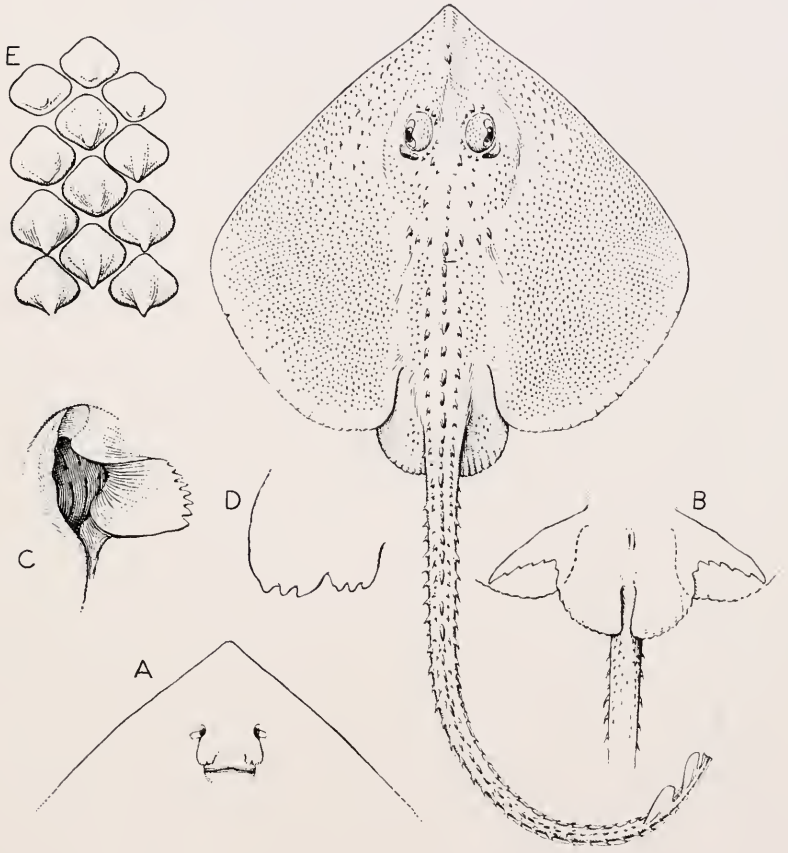
E
C
D
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PLATE 6

## PLATE 6

*Breviraja spinosa*, sp. nov., female, 288 mm. long, type specimen, off northern Florida, Lat. 30°58′N., Long. 79°34′W., 250–290 fathoms (Mus. Comp. Zoöl., No. 36373). A Lower surface, mid-anterior part of head. B Pelvic fins. C Side view, posterior part of tail, about 0.8 x. D Left-hand nostril, about 4.4 x. E Margin of right-hand nasal curtain, about 4.4 x. F Upper teeth, about 9 x.

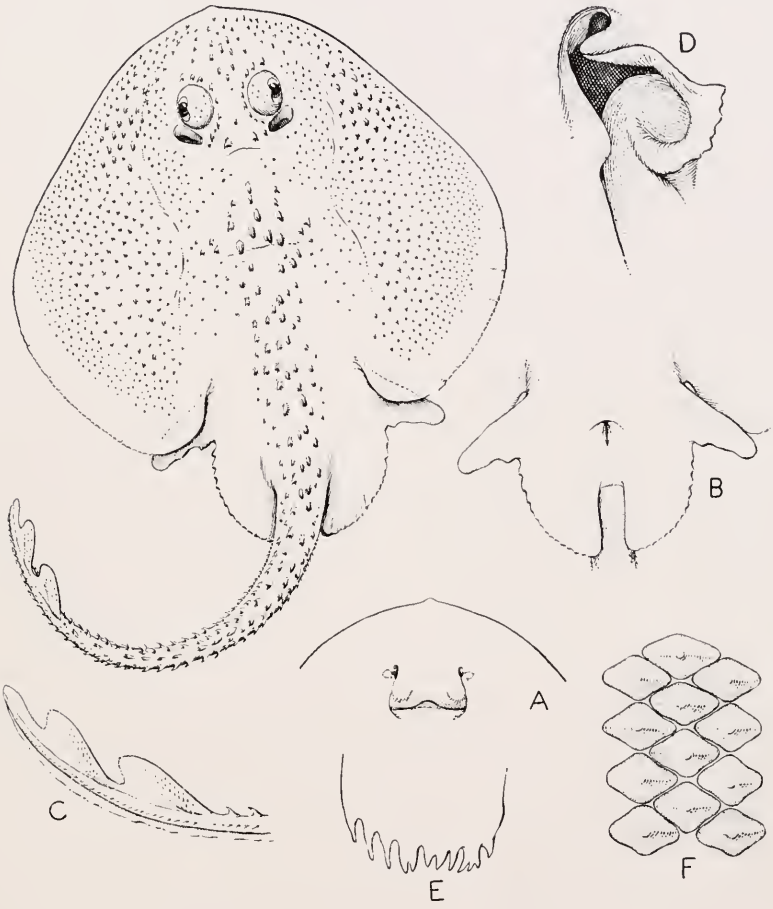
D
B
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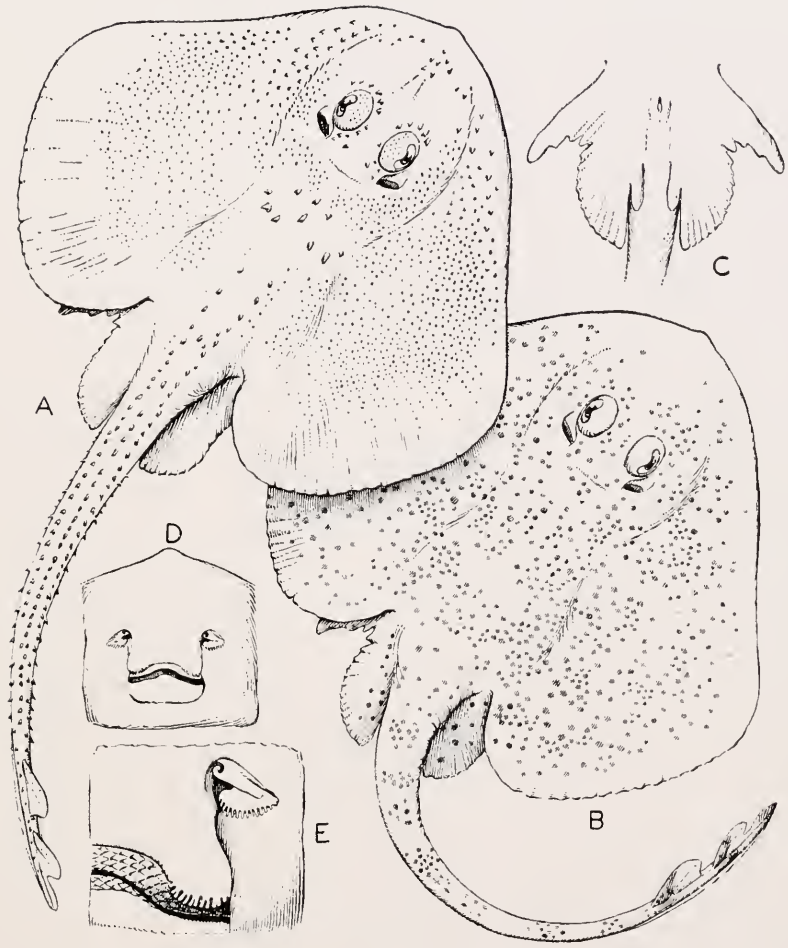
PLATE 7

## PLATE 7

*Breviraja yucatanensis*, sp. nov., juvenile male, 215 mm. long, type specimen, northeast slope of Yucatan, 231 fathoms (U. S. Nat. Mus., No. 148273). A Dorsal view to show thorns and prickles. B Same, to show color pattern, dermal armature omitted. C Pelvic fins. D Ventral view, mid-anterior part of head. E Nasal curtain and margin of nostril, about 2.7 x.


A
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**Bulletin of the Museum of Comparative Zoölogy**
AT HARVARD COLLEGE
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# FRONTAL SINUS EVOLUTION (PARTICULARLY IN THE EQUIDAE)

BY TILLY EDINGER

WITH NINE PLATES

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No. 8 — *Frontal sinus evolution (particularly in the Equidae)*

By Tilly Edinger

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## I. ACKNOWLEDGEMENTS

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## II. THE EQUUS CONDITION

Pneumatic spaces occupy large areas in the head of the adult common horse. They are the three pairs of paranasal cavities: the sphenopalatine, maxillary, and frontal sinuses.

The body of the sphenoid contains a cavity halved by an irregular median osseous septum. The *sphenoidal sinus* continues laterally into the palatines (fig. 3C), or there are separate *palatine* sinuses.

A *maxillary sinus* pneumatizes the posterior region of each upper jaw. Its main portion usually lies over the two posterior molars, and it never reaches farther forward than over $M^1$. The anterior limit of its more dorsal portion is always the infraorbital foramen, the vertical, slit-like opening of the canal which runs horizontally forward from the orbit, within the sinus. Expanding during ontogeny, the maxillary sinus spreads into the lacrimal and zygomatic bones. Thus it extends along the front wall and floor of the orbit (fig. 1). The posterior ends of the maxillary sinuses present a graphic example of a sinus characteristic, variability. In the cross-sectioned skull described below, a posterad[1], tapering diverticle pneumatizes the anterior half of the suborbital shelf. The corresponding left side diverticle, however, is wider and hollows the entire shelf. Thus it hollows practically the entire zygomatic bone — it tapers out where the zygomatic narrows to a slender tongue underlying the zygomatic process of the temporal bone. Ontogenetic expansion of the maxillary sinus is also brought about by the progressive extrusion of $M^2$ and $M^3$, so that in old horses the maxillary sinuses are the largest of the three pairs; length varies from 125 to 185 mm., breadth from 60 to 85 mm. (Baum 1894).

[1] The Latin suffix -ad, expressing a direction toward, does not seem to be generally used in the American scientific language, particularly not to form adjectives, but its use has simplified the present paper's descriptions of cavities extending, during ontogenies and phylogenies, in this and in that direction.

The right and left frontal sinuses are separated only by a double sheet of bone, the septum sinuum frontalium, whose thickness varies around 1 mm. The pair constitutes the largest pneumatic area in the horse skull. Among the numerous detailed investigations of these cavities, those based on the most material are those of Goubeaux 1852, Baum 1894 (66 skulls of 5-to-15 year-olds), and Bressou 1919 (40 fresh heads and 43 skulls, from 4 years to very old); a more recent one is Anthony 1929, and shorter descriptions are found in textbooks such as Sisson 1940. These studies have established the following conditions in the adult common horse.

Each frontal sinus lies primarily between the tabulae externa and interna of the frontal bone. Laterally it extends into the supraorbital (zygomatic) process of the frontal. Posteriorly it may reach almost to the fronto-parietal suture (14% of Bressou's cases). Anteriorly it has a dorsal extension into the nasal bones. Laterally, too, it continues

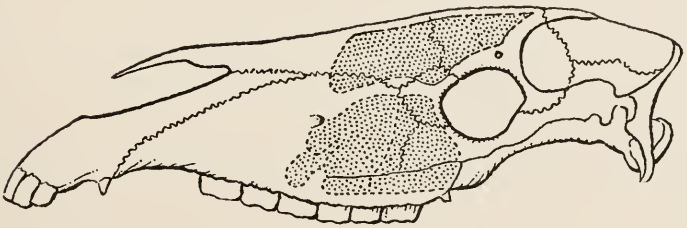


Fig. 1. *Equus caballus.* Topography of left frontal and maxillary sinuses. After Bressou (slightly changed). 1/6 nat. size.

beyond the frontal bone — along the ethmoidal labyrinth, roofed in by the lacrimal, nasal, and maxillary bones. Its osseous floor is interrupted by a wide opening, up to 45 mm. long and 35 mm. broad (pl. 1 = fig. 8, f.m. — a communication with the maxillary sinus. Anterior to this there is a tapering anterad section of the frontal sinus. This extends into the posterior part of the dorsal (naso-) turbinate bone. It is anteriorly closed off, by a transverse wall, from the anterior part of the dorsal turbinate (which part alone functions, with scrolls, as a nasal turbinate). This anterior extension of the sinus is often called pars turbinalis sinus frontalis. Sinus nomenclature varies considerably, depending on the importance an author attributes to the connections of the sinuses — with each other, with the nasal cavity, and between the compartments of each sinus. The present study is not concerned with such details as these communications and subdivisions.

Although Bressou found that the frontal is that sinus whose dimensions vary least, its variability in shape and size is nevertheless great and is strictly individual. At least from the 4-year-old on (the youngest horse studied in this respect), variation is neither related to age, nor to the slight variations in skull roof profile, nor to skull size, nor are the right and left frontal sinuses of one head necessarily similar. In Baum's material of 530 to 600 mm. long skulls, the diameters of the frontal sinus varied as follows (1894, p. 166–169): length, 130–200 mm.; height, 55–80 mm.; breadth, 55–80 mm. Greatest height and breadth were found to occur in approximately the same transverse plane.

None of the descriptions summarized above gave me a full picture of the actual position of the frontal sinus, namely, a picture including the relation of the frontal sinus to the structural units it adjoins within the horse skull. I studied this, particularly, in two skulls of adult horses. No. I (MCZ, Mammal Dept. No. 1713) is 580 mm. long and shows wear of all 3 premolars; it is halved sagitally close to the median plane, so that in one half the septum sinuum hides the sinus — the sinus of the other half is shown in fig. 9. Paramedially, the sinus is 92 mm. long; laterally, 160 mm. No. II (MCZ, Mammal Dept. No. 43500) is 560 mm. long, has the first premolar and some of the second worn, and was transversely sectioned across the posterior region of the orbits. In this specimen (pl. I, fig. 8) I broke away the dorsal outer plates of the frontal bones and explored the sinus in detail. Shooting this horse in the forehead had destroyed the anterior sinus extensions. Maximum breadth of the sinus pair is 150 mm. The greatest depths are 53 mm. on the right and 46 mm. on the left side; they lie 1–2 mm. anterior to the plane of greatest width.

This transverse region of greatest sinus volume passes about 10 mm. behind (not "vor" — Baum 1894, p. 168) the posterior extremity of the dorsal rim of the orbit. Naturally, the sinus has its greatest width where it extends into the postorbital processes. All figures in the literature locate the lateral end of the frontal sinus at any odd place between the root of the postorbital process and the postorbital foramen; only Hamoir describes and figures the orbital diverticulum as continuing laterad behind the foramen (1918, p. 412 and fig. 4).

Both the sinus of my No. I specimen which can be probed and the left sinus of II end laterally with a tapering tip in the postero-dorsal rim of the postorbital foramen. They seem to come to an end at a naturally given point (a point not reached by the right sinus of II): the proximal wall of the supraorbital foramen. This so-called foramen is in *Equus* rather a canal. It perforates perpendicularly the postorbital process which at this point is 10 mm. high. The minimum lumen of the canal is 5 mm., its funnel-like dorsal exit is 9 mm. in diameter.

From braincase to canal the postorbital process is a voluminous structure; by the canal it is divided into two smaller units, which join distal to the canal to form a comparatively slender bar. The postorbital diverticulum of the frontal sinus ends just proximal to the canal's greatest width. The canal thus appears to set a natural limit to the laterad extension of the frontal sinus, particularly as this condition recalls the configuration at the anterior end of the maxillary sinus, which always coincides with the infraorbital foramen.

Immediately proximal to the supraorbital canal the left sinus of II has a groove in its floor so that it is here, near its lateral end, still a 15 mm. high cavity. This groove is not developed on the right side; there the sinus floor, from next to the supraorbital canal, slopes evenly proximad towards the greatest depth of the sinus. The sinus floor in this region is formed by the outside wall of the cranium under, and just behind, the postorbital process; it is to some extent orbital, mostly temporal fossa wall.

Neither measurements nor figures can convey the real picture of the region of greatest sinus depth. Figures in the literature show either a side view like our fig. 1, or a section. The longitudinal section always chosen to demonstrate the frontal sinus is that next to the septum sinuum frontalium (our fig. 9). However, the deepest pocket of the sinus floor is neither lateral nor median in the skull, but intermediate in position. It is in a situation which appears to be fixed by the topography of the brain capsule.

It is in fact impossible to reproduce in the two dimensions of an illustration the impression obtained upon removal of the sinus roof, that practically horizontal, even sheet of bone which at first sight, in a whole skull, seems to be the entire frontal bone but is only the tabula externa ossis frontalis. It roofs a vast empty space: the frontal sinus. The sinus is irregularly halved by the more or less median, more or less perpendicular septum sinuum frontalium. The curves of the lateral and posterior outlines of this cavity are interrupted by irregular diverticula, or rather by the septa between them, which jut into the sinus perpendicularly, obliquely or even (from the left orbit of II) horizontally, in straight or sinuous fashion. Yet a major part of the sinus floor has a very definite shape. This is in the main and posterior regions of the sinus, and is the real roof of the anterior brain cavity, shaped by the brain.

Medio-sagittal sections of the skull (fig. 9) show the sinus in the sagittal plane of its shortest anter-posterior extent. In this section, next to the septum, the sinus appears triangular. The "base" of the triangle is in the skull roof; the "apex" is below in a transverse furrow of the braincase roof. Below this furrow, inside the braincase, is the

dorsal contact of cerebral hemispheres and olfactory bulbs. The transverse furrow on the dorsal, sinus-side of the braincase corresponds to the furrow, on the dorsal surface of the brain, between cerebrum and bulbi. The transverse ridge on the endocranial surface of the frontal bone which contains the part of the sinus here described is, so-to-speak, a septum dorsally separating the two brain portions. Its lower rim frames, from above, a pair of intracranial perpendicular windows, in which the cerebro-olfactory contact takes place. These windows (see fig. 7C) apparently have not been named; they may be called ethmoidal or olfactory windows. From the transverse paramedian furrow which indicates the position of these windows on the dorsal surface of the braincase, to the skull roof above, the sinus is 35mm. high in the No. I specimen, 38 mm. in II.

Anterad from here the sinus floor rises over the roof of the ethmoidal chambers (fig. 8, O.) and the nasal cavity until it joins the skull roof, that is, the tabula externa of the nasal bone. Lateral from these paramedian cone-shaped portions the sinus cavities are continued much farther forward. There is a large section pneumatizing the orbit roof and wall. Here there is, in the floor from at least the middle of the orbit forward, the wide-open connection with the maxillary sinus, and the sinus walls are more lacrimal and maxillary than frontal bone. Beyond the anterior end of the orbit is the turbinate extension, topographically part of the nose; it lies between the maxillary sinus and the vaulted dorsolateral roof of the muzzle.

Lateral from the region above the ethmoidal windows the sinus floor drops to its deepest point (fig. 8, P.). There the right sinus of II is 53 mm. deep, the left one 46 mm. This pair of basal pockets are 59 mm. distant from each other, symmetrically situated, immediately lateral to the cerebro-olfactory windows inside the braincase, and thus immediately in front of the anterior extremities of the cerebral chamber. They are funnel-shaped, their outside walls being in the basomedially-slanting lower region of the cranium walls.

In all the descriptions of frontal sinuses which I have read, I found just one reference to such basal pockets. Lechner writes [1](1932, p.277): "Near the median septum the sinus floor has a groove which extends farthest basad, but does not reach the sphenoid wings. This recess lies lateral to the ethmoidal fossa. It might be called a hollow stem on which rests the frontal sinus like a funnel-shaped pyramid. Lateral to it the sinus is considerably more shallow and juts out into the beginning of the zygomatic process". It is the skull of *Felis domestica* which Lechner describes. Such pockets are shown in Paulli's figure of a cross-sectioned cat skull (1900, fig. 17) but are not mentioned in Paulli's

[1] I have translated foreign language quotations.

text. They are no doubt frequently present in pneumatized mammal skulls, and they are a significant feature.

In *Equus caballus*, at least, position and shape of the widest sinus region appear to be determined by position and shape of the ethmoidal and cerebral chambers. This fact, incidentally, may be the reason why in horses a laterad diverticulum may reach behind the postorbital foramen but has never been observed anteriorly. There is as much or more room for sinus expansion within the postorbital process anterior to as posterior to the foramen; but it is the posterior portion of the process which continues laterad the plane between ethmoidal and cerebral chambers.

Posterad from this transverse region of greatest breadth and depth, the floor of the sinus is the wall over the anterior slope of the cerebral hemispheres (fig. 8, C.). Its squarish outline and its profile mirror those of the frontal region of the cerebrum; its prominences correspond to the impressions of frontal brain gyri in the ventral side of this inner plate of the frontal bone, and the grooves in this portion of the sinus floor correspond to cerebral sulci. Thus the sinus here envelops, dorsally and laterally, the anterior region of the cerebral cavity. Its breadth is fairly uniform, 72 mm., from the anterior poles of the cerebral chambers to about 30 mm. behind them. The sinus thus extends over the whole breadth of the anterior cerebrum.

There follow posterad what Bressou (1919, p. 275) describes as diverticulations at the posterior extremity of the frontal sinus. Rather, in this region each sinus tapers concomitant with the gradual approach towards each other of the outer cranial wall and the braincase. In our specimen whose whole sinuses are laid open (fig. 8), the "median" septum turns to the right so that the left sinus has become, at its posterior end, a practically median and symmetrical formation. This posterior end is rounded, and the point of greatest posterad extent is only 3 mm. to the left of the midline of the skull. Next to it, the sinus is still 15 mm. broad and 5 mm. deep. The right sinus tapers similarly in depth and breadth, but ends 10 mm. more anteriorly. Thin perpendicular walls of compact bone close these sinus extremities against the spongiosa which lies between the tabulae externa and interna posteriorly — viz., where the dorsal surfaces of skull and cerebrum are close to each other and are parallel.

These posterior regions of the frontal sinuses are stated in the literature to be particularly variable in posterad extent. Bressou describes this be saying that the sinus ends between 20 and 60 mm. behind a line connecting the *posterior extremities of the orbits* (1919, p. 275; Hamoir's surgical study uses the same orientation, 1918, p. 412). Baum reports that the caudal end of the sinus lies in one transverse

plane with the *anterior border of the lower jaw articulation* or up to 10 mm. anterior to this, and thus one or two fingers' breadth behind the *zygomatic process of the frontal bone* (1894, p. 166). Such connecting of the end of the frontal sinus with distal skull regions — distant and unrelated to the sinus, and perhaps themselves variable — hardly illustrates the posterad extent of the sinus which, to us, appears determined by the shape of the *braincase*. We find that in brain morphology lies the reason why in one individual the sinus reaches farther posterad than in another individual.

The sinus floor follows the cerebral surface posterad up its anterior slope to the horizontal brain surface, where it ends. The sinus variations are not greater than, in fact they correspond to, the variations of that brain region. The frontal lobe of *Equus* has an anterior facies of very variable steepness. Adjoining the olfactory bulbs, the profile is perpendicular up to variable heights; this is followed posterad by an upward slope of variable length. The horizontal part of the dorsal surface of a cerebral hemisphere thus begins at different distances from the anterior poles. It is at this variable location that there remains no gap between the tabulae externa and interna, and each sinus comes to a brain-determined posterior end. This is particularly well illustrated in our specimen II in which the left sinus extends farther back than the right and into the medial area; its tapering, symmetrical extremity follows to the end the symmetrical anterior slope of the cerebrum.

Bressou remarks (1919, p. 275) that there is nothing which allows one to predict, nothing which explains the variations of frontal sinus capacity in the horse. Our observations restrict the scope of this statement to the anterior regions, whose irregularities, like those of the dorsal and lateral sinus borders, are minor variations characteristic of sinus formation. As regards both the vastest and the posterior regions of the frontal sinus, it is the variations of the anterior profile of the brain which are unpredictable and unexplainable, but they account for the sinus variations.

Thus the sinus frontales, twin cavities in the middle region of the horse skull, occupy the spaces between

1. dorsally, the skull roof;
2. laterally, the side walls of the skull forming and adjoining the orbits;
3. medially and basally, (a) the posterior region of the nasal cavities, (b) the ethmoidal chambers which contain the olfactory bulbs of the brain, and (c) the anterior region of the cerebral cavity with that part of the cerebrum whose dorsal surface slopes anterad.

Further, the frontal sinus continues anteriorly into a non-nasal turbinate cavity, and in its transverse plane of greatest depth and breadth it extends into the postorbital process.

As the different lengths of the postorbital diverticulum suggest, this extension of the frontal sinus grows laterad even during adult life. Paulli's pl. IX (1900; briefly referred to p. 191, p. 249) shows in side view the skull of a newborn foal with the sinuses laid open; the frontal sinus reaches no farther posteriorly than to the transverse plane connecting the anterior borders of the postorbital processes. No special study seems to have been made of the ontogeny of the frontal sinus in the horse, but of other mammals it is well known that pneumatization increases in extra-uterine life at least as long as the skull grows. Weidenreich has culled from the literature the facts that in calves, kids and elephants the frontal bone is not pneumatized at birth (1924, p. 82). The "very young", 308 mm.-long skull of a giraffe shows no trace of pneumatization, at least not in a sagittal section of the frontal and parietal bones (Lankester 1907, fig. 29); both these bones are highly pneumatized in adult giraffes (our fig. 7C). Ghetie (1941) studied the sinuses of the pig in a series of skulls which included those of very young and very old individuals. Of the eleven sinuses which this author distinguishes, the youngest pigs have only the maxillary sinus. Next to appear is a cavity in the anterior and lower regions of the frontal bone (loc.cit. p. 171, p. 174), the future "frontooccipital sinus". All sinuses were found to expand up to old age (p. 171).

Several studies of maxillary sinus development in ungulate embryos, while not mentioning the frontal sinus, attest to the fact that the latter develops later than the former. The recessus which is the Anlage of the maxillary sinus (an epithelial tube long preceding bone formation) appears in pigs in a 25 mm. embryo (Dennhardt 1903, p. 13), has a closed lumen in the 28 mm. embryo (p. 14), and the "turbinate sinus" is first seen in the 34 mm. stage (p. 18; the sphenoid sinus is not mentioned). In Dennhardt's sheep material, maxillary and turbinate sinus Anlagen are present in the youngest, a 34 mm. embryo. The frontal bone Anlagen, however, are described as "solid" (p. 35) in the oldest pig and sheep embryos studied, 160 mm. and 100 mm., respectively.

In horses (Sörensen 1934) the lumen of the future maxillary sinus first appears in the 27 mm. embryo (p. 625), and sphenopalatine and turbinate sinus Anlagen appear in the 180 mm. embryo (p. 630). The oldest embryo (290 mm.) has the maxillary sinus similar to that of an adult, except for size, and it reaches the orbit (p. 632–633); but there is no trace of a lumen in its frontal bone Anlage, at least not in the regions shown in Sörensen's figs. 12 and 13.

When and how did this voluminous structure of the head of the horse appear in the series of adult ancestors of the extant form?

The numerous special investigations of the *Equus* paranasal sinuses do not even speculate upon this question. Their viewpoints are veterinary — with particular regard to surgery —; or they com-

pare the anatomy of extant mammals, or are purely descriptive. In the large literature on the fossil ancestors of *Equus* there seems to be only one reference to skull sinuses, and this is a case of mistaken identification.

When the evolution of the equid brain was studied from *Hyracotherium* (eohippus) to *Equus* (Edinger 1948), observation of the circum-cerebral skull regions revealed that no frontal sinus existed when the Equidae evolved from the common ungulate stock in the Lower Eocene.

## III. THE EQUID FOSSIL RECORD

### 1. Description

*Hyracotherium* (Lower Eocene). Numerous fragments were studied of *Hyracotherium* skulls belonging to the Museums listed on p. 412, the Carnegie Museum, Pittsburgh, Pa., and to Dr. Horace Elmer Wood of Rutgers University at Newark, N. J. The broken surfaces of these fragments expose sections of frontal bones in a variety of places. Nowhere was a pneumatic space discovered within the frontal.

The specimen chosen to illustrate the structure of *Hyracotherium* frontal bones is the fragment of the *H. venticolum* muzzle AMNH 14810 which is figured in its entirety in my 1948 paper, fig. 4. It is prepared so as to lay open the matrix in the nasal tunnel, in the right ethmoidal chamber, and in the anterior cerebral cavities. The bulk of the left frontal bone is left in situ (with, perhaps, the adjoining nasal bone region); the right frontal bone is sawed off 1.5-2 mm. from the median suture. Natural breakage has produced three sections through the bone:

1. anteriorly, a crooked transverse section. This is the irregular border of the bone as preserved. Above the ethmoidal labyrinth the frontal bone is paper-thin, slightly thicker more medially over the ethmoidal chamber as seen at the right end of fig. 10.

2. posteriorly, a transverse section through the roof of the cerebral chamber near (5 mm. behind) the anterior poles of the hemispheres. This section (fig. 11) shows conditions inside the frontal bone in a transverse plane 4-5 mm. behind the posterior border of the postorbital process. There is a thin tabula externa, a thicker tabula interna, and between the two a layer of cancellate bone.

3. laterally, an approximately sagittal section through the root of the left postorbital process. In this section the process is triangular;

the perpendicular posterior border is 5 mm. high, the anteriorly converging borders each are 4 mm. long. Thin compacta encloses a nucleus of spongiosa.

The 4th section is an artificial one, that made by the saw, paramedial through the right frontal (fig. 10). It includes the roof of the most anterior slope of the right cerebral hemisphere; the ventrad transverse ridge of the frontal between cerebral and olfactory bulb chambers; and the anterior tapering portion of the frontal which overlies olfactory chambers and ethmoidal labyrinth. Thus this section includes the transverse plane of greatest frontal bone thickness which is in *Equus*, as we have seen, the plane of greatest frontal sinus depth. In *Hyracotherium*, however, only a transverse septum is formed by the endocranial side of the frontal bone. While triangular in paramedian section like the corresponding formation in *Equus*, it is a different structure. From the "base" in the skull surface, the apex of this triangle reaches down 6 mm. into the skull. The same measurement of greatest frontal bone thickness was obtained in a *Hyracotherium validum* specimen (YPM, VP-11694; this natural endocranial cast, with the skull base *in situ*, is 20 mm. high medially in the plane where cerebrum and olfactory bulbs adjoin, while the plaster cast taken of this skull before the roofing bones were removed is here 26 mm. high). As is seen in fig. 10, throughout this region, too, only tiny-celled cancellate tissue intervenes between the compact inner and outer plates of the frontal bone. It follows that the frontal sinus proper was not developed in *Eohippus*.

On the other hand, a maxillary sinus existed. In *Hyracotherium* the orbit is above the posterior grinders, not posterior to the teeth as in *Equus*. The floor of the orbit seems to overlie the teeth closely in undamaged maxillaries, such as the right one of the AMNH muzzle. From the left maxillary of this specimen a perpendicular break has removed the last molar tooth. The transverse section of the jaw thus revealed is plastered over laterally, but above the medial part of $M^2$ shows a once empty space, now stone-filled. It is 5 mm. high, its medial bone wall about 3 mm. thick. This cavity is not the infraorbital canal; on the right side of the specimen this canal is seen to end in the orbit in a plane much anterior to our section. The cavity above the $M^2$ can be interpreted only as a pneumatic space, a maxillary sinus.

*Mesohippus* (Middle Oligocene). Scott (1891) figured a longitudinally sectioned *Mesohippus* skull together with one of *Equus* (pl. XXIII, figs. 17 and 18). It must have been the result of direct comparison of the two that Scott designated the dorsal ante-cerebral chamber — a chamber in the area which in *Equus* is part of the frontal sinus — as the frontal sinus of *Mesohippus* (p. 406.--Ibid.

p. 307 and Scott 1941, p. 915: "The frontal sinus is but little developed and does not extend over the brain at all"). However, the endocranial casts of *Mesohippus* show that the chamber in question is the ethmoidal; the space was occupied by the olfactory bulb when *Mesohippus* was alive. Scott's figure, incidentally, is not a good reproduction. The specimen itself (Princeton University no. 10503) shows that the figured surface of the right skull half is the mediosagittal plane. The ostensibly lateral, 21 mm. long process coming down from the skull roof is actually in the plane of section; it is the longitudinally sectioned median ridge (ethmoidal crest) between right and left ethmoidal chambers.

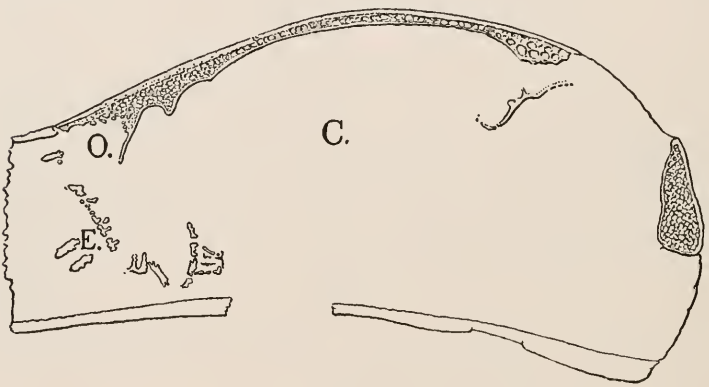



Fig. 2. *Mesohippus* sp. (M.C.Z. 6594). Right half of skull fragment, paramedian section. Nat. size.

In the sectioned surfaces of both right and left halves of this skull the frontal bone is seen to consist of rather thick tabula externa, small-celled cancellate layer and thin tabula interna. In the right skull half, the matrix is removed from the cerebral chamber so that the transverse ethmoidal window is revealed. Its upper rim is about horizontal, 10 mm. below the outer surface of the frontal bone. The left half of the skull shows that the region in which the frontal bone is thickened to form, with its inner plate, the roof of these windows, is 15 mm. long.

*Mesohippus* MCZ 6594 supplements the data gained from the Princeton specimen, as this skull is longitudinally sectioned not medially but just to the right of the midsagittal plane. It therefore shows in section the frontal bone above and between the right cerebral and ethmoidal chambers (fig. 2). There was an 8 mm.-deep transverse septum sloping down over the anterior cerebrum. Its lower part is

very thin. This condition had been suggested by the endocranial casts, in all of which much of the olfactory bulbs is closely applied to the cerebrum. Only the upper 5 mm. of the septum is thicker and contains cancellate tissue. Anteroposteriorly the thickened part of the frontal bone is 23 mm. long. Posterior to the septum proper one sees the tabula interna protrude into the two transverse sulci on the anterior surface of the cerebrum. Of these two juga cerebralia, the anterior one is constructed like the septum, but the posterior one is in the zone of posterad tapering of the thickened region. Anterad, this region tapers so that over the anterior part of the olfactory bulbs there is hardly 1 mm. of bony roof.

The cross-sectioned *Mesohippus* skull, Princeton University no. 11114 (fig. 3, A, B; the sectioning destroyed about 1.5 mm. between these two surfaces), shows the olfactory bulb chambers 3–5.5 mm. anterior to the cerebro-olfactory septum. It is seen that these ethmoidal chambers were not, as in *Equus*, deep within the skull, but immediately adjoined the skull roof. This consists of frontal bone with but a narrow layer of spongiosa. Likewise, the lateral wall of the ethmoidal chamber was cranial wall, namely, the pars orbitalis ossis frontalis: a dorsal portion of the medial wall of the orbit. This is not preserved in the endocast preparation shown in fig. 3; but in other *Mesohippus* specimens it can be seen, not pneumatized as in *Equus*, but as a 1 mm.-thick sheet of bone between orbit on the outside, olfactory bulbs and ethmoidal labyrinth on the inside.

It thus appears that there was no pneumatization anywhere in the frontal bone of *Mesohippus*.

The *Mesohippus* upper jaw fragment MCZ 17659 was cross-sectioned at the posterior end of $M^2$. The section shows the infraorbital canal, and lateral to this, above $M^2$, an 8 mm.-wide maxillary sinus.

*Miohippus* (Upper Oligocene). A *Miohippus* specimen loaned to me for brain study (from Princeton University; no. 11127) was a braincase when received. To reveal the endocranial cast, the bones were chipped off and thus do no longer exist. It was noted that over the posterior region of the olfactory bulbs and over the anterior cerebral region each frontal bone contained an extensive nucleus of cancellate tissue. The spongiosa cells were larger along the median plane than laterally, and larger also than any seen in *Mesohippus*. Unfortunately the depth of the frontal bone was not measured.

*Parahippus* (Lower Miocene). In the *Parahippus* skull fragment MCZ 17878, "A mass of cancellate frontal bone, more extensive in every direction than the corresponding region in the frontal bone of

*Miohippus*, was removed in search of the olfactory bulbs" (Edinger 1948, p. 70). It was then recorded that the thickness of frontal bone matter was 23 mm. between the cerebral and ethmoidal chambers, and 14 mm. above the highest vault of the latter. We have preserved in fragments much of the bone chipped off in this preparation, and left

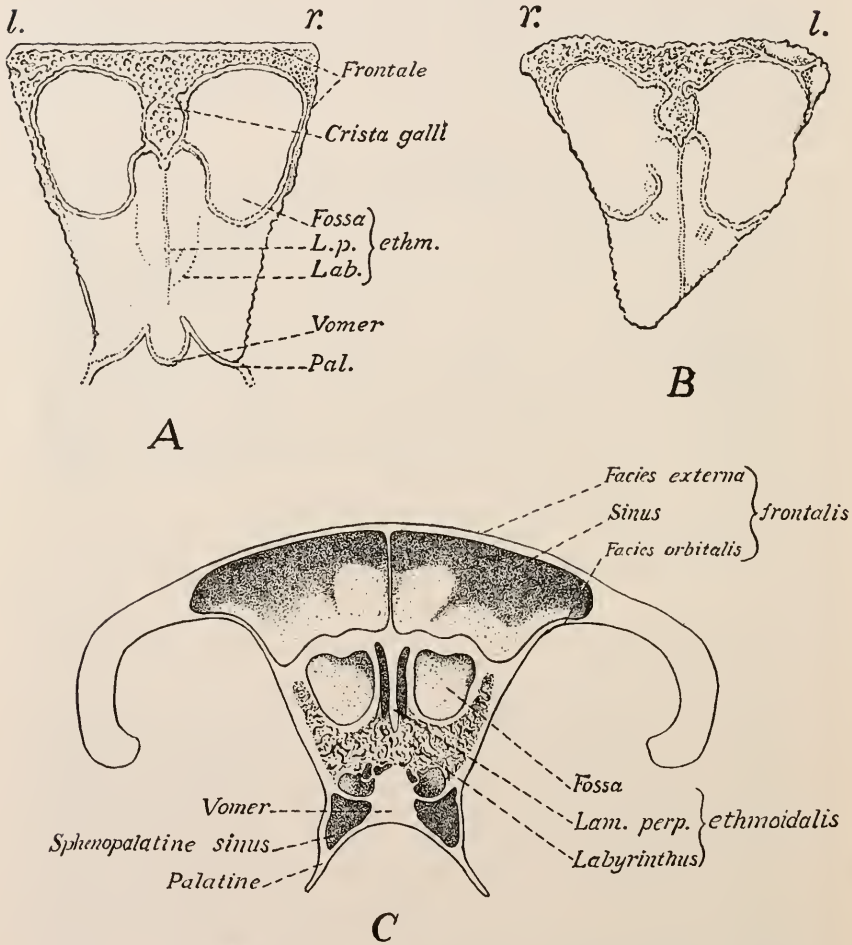



Fig. 3. A, B: *Mesohippus* sp. (P.U. 11114). Approximately transverse section across olfactory chambers (fossae ethmoidales); A: distal, B: proximal side. 1½ x nat. size. C: *Equus caballus*. Distal side of skull sectioned across olfactory chambers and postorbital bars. After Baum. ⅜ nat. size. (From Edinger 1948.)

in situ the cranium along the midline and over the left cerebral hemisphere, plus some of the tabula interna frontalis covering the olfactory bulb casts. Thus this specimen contains many sections through the frontal bone. Nowhere was a pneumatic cavity discovered.

The longitudinal section of the frontal over the right cerebral hemisphere (13 mm. from the midline) is typical of the relatively thin areas, such as is also the roof of the posterior orbit; over the vault and the anterior slope of the cerebrum, the external compacta is ± 4 mm. thick, the internal compacta much thinner, and there is a 2–4 mm.-high layer of spongiosa. The cross section above the cerebro-olfactory furrow shows the typical thick region; below the 4 mm.-thick outer plate is an irregular layer of small-celled spongiosa, and the wide area below this, down to the thin inner plate, is occupied by coarse, wide-celled spongiosa.

Thus the structure of the frontal bone is basically the same throughout, in thin and in very voluminous regions. This early representative of the *Parahippus* group had no frontal sinus.

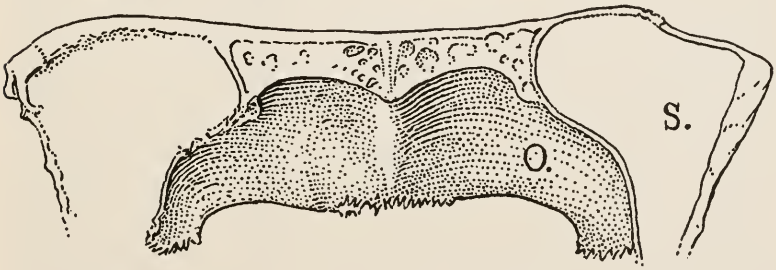



Fig. 4. *Merychippus* sp. (A.M.N.H. 32671). Frontal bone broken over olfactory chambers, anterior view. 2 × nat. size.

*Merychippus* (Middle and Upper Miocene). A Middle Miocene skull roof fragment and a broken neurocranium from the Lower Upper Miocene show that in *Merychippus* frontal sinuses were developed.

*Merychippus* sp., AMNH 32671, from the Sheep Creek beds, is a portion of a braincase roof which ends anteriorly in an irregular break (fig. 4). In this crooked cross section can be studied medially the structure of the frontal bone above the posterior part of the ethmoidal chambers. Laterally the break runs backward on either side towards the plane of the ethmoidal windows, thus sectioning the frontal also at its greatest thickness. Here, there was found a pair of lateral compacta-lined spaces in which there is nothing but matrix: remnants of frontal sinuses. Their endocasts are 11 mm. deep, but the sinuses were deeper, as the casts are broken on the lower side of the specimen. In

ventral view this break has a subcircular outline, with about 4 mm. diameter. There were, consequently, pits in the sinus floor lateral to the ethmoidal chambers as in *Equus*. Cancellate tissue is seen on the left side of the transverse section only in the relatively thin bone over the ethmoidal chamber vault. Above the right ethmoidal chamber, loss of inner plate material has laid open more of the interior bone structure in this paramedian region. It seems that each frontal bone was filled with spongiosa to a breadth of 10 mm. outward from the median suture; that, consequently, the frontal sinuses were lateral only, separated by about 20 mm. of cancellate tissue. The specimen discloses neither how far the sinuses extended nor, of course, their rostrad extent.

The *Merychippus* sp. neurocranium AMNH 9393 (Pawnee Creek beds) ends anteriorly in an irregular series of breaks. In the cross break of the left frontal bone are seen, (1) cancellate tissue 14 mm. broad lining the dorsal outer plate, about 4 mm. broad laterally, 10 mm. broad next to the inner plate, and (2) enclosed by these spongy regions, an ovoid posterad groove, 10 mm. across and 5 mm. high, which is lined with smooth compact bone. This was the posterior end of the left frontal sinus. It is a cavity situated above the anterior slope of the left cerebral chamber and thus posterior to the section exhibited in the Middle Miocene specimen; the sinus extended farther back in the larger and later than in the smaller and earlier *Merychippus*. — On the right side of the Upper Miocene specimen the dorsal plate of the frontal bone is plastered over at the break; but on this side the neurocranial side wall is preserved farther forward than on the left side. It includes the lateral wall and a posterior part of the roof of the olfactory bulb chamber. Two more items relating to the frontal sinus are revealed here. Where the ethmoidal chamber adjoins the cerebral chamber, its roof, i.e. the tabula interna of the frontal bone, is 10 mm. below the tabula externa. Further, this tabula interna is as smooth dorsally as it is ventrally where it covered the olfactory bulb. Consequently, no cancellate matter lay over at least the latero-posterior part of the ethmoidal chamber, but a frontal sinus.

### 2. Interpretation

As demonstrated by the material described on the preceding pages, maxillary sinuses were present in the oldest of the ancestors of the horse, 55,000,000 years ago, whereas frontal sinuses were not developed before the Middle Miocene, 20,000,000 years ago.

Conditions in extant Mammalia have previously suggested that maxillary sinuses are "the original form of pneumaticity in the Placen-

talia" (Paulli 1900, p. 561). The oldest Equidae substantiate the conception that, as the neo-zoologist puts it, "the oldest form of pneumaticity in placental mammals is the maxillary sinus of the insectivores" (loc. cit., p. 559).

The origin of additional pneumatization has been variously explained on the basis of recent materials. Only one of these generalizations is interesting at the present point of our special study of the formation of a sinus in one phyletic series. This theory concerns the form of the skull. Frontal sinuses are supposed to be related to the formation of superstructures such as horns, forehead, crests. But the Equidae never developed superstructures — on the contrary; *Hyracotherium* had the parietals and frontals crested, and the crest was reduced to a vestige as the skull enlarged. Apart from this reduction and a greater increase in length of its facial than its cranial part, the skull has generally preserved the same appearance from *Hyracotherium* to *Equus*. In particular, there was always a practically flat skull roof.

It therefore seems that the changes which in the Equidae originated the frontal sinus took place in relation to intracranial structures.

We have seen that the frontal sinus proper of *Equus* is the space between level skull roof, anterior slope of the cerebrum, olfactory bulbs, ethmoidal labyrinth 7, and orbit. We have further located the oldest frontal sinus in the history of the Equidae between skull roof, cerebrum and bulbi. Going back to the earlier Equidae, we find that the space thus occupied did not exist in the earliest forms.

The origin and evolution of this intra-cranial space is illustrated by the numbers given in our table of perpendicular measurements in the skull region which lodged the olfactory bulbs and, in the later forms, also contains part of the frontal sinus.

The bulbi of *Hyracotherium* were relatively large formations anterior to the cerebrum, where they occupied the entire breadth and practically the entire height of the cranium (Column I). The skull roof likewise fitted on the cerebrum whose dorsal profile was a low curve. The inner plate of the frontal bone did, of course, protrude downward where it had to separate cerebrum and bulbi. However, it formed no more than a low, narrow transverse crest (column II; see fig. 10). The antero-posterior diameter of this crest is ventrally only 1 mm. The crest protrudes into the skull interior for only about one-fifth of the skull height (column IV).

*Table of perpendicular skull measurements in the olfactory bulb region.*

I. Thickness of frontal bone above highest vault of ethmoidal chamber (the chamber which contained the olfactory bulb).

II. Thickness of frontal bone paramedially at ethmoidal window (through which ethmoidal connects posteriorly with cerebral chamber).
III. Total skull height in the same place as II (dorsal surface of skull roof — facies frontalis ossis frontalis — to ventral surface of palate).
IV. Ratio of II (= 1) to III.

| | | I | II | III | IV |
|---|---|---|---|---|---|
| *Hyracotherium* | YPM, VP 11694 | 3 | 6 | 26 | 5.2 |
| | AMNH 14810 | 2 | 6 | 28 | 4.7 |
| *Mesohippus* | PU 10503 | 2 | 10 | 35 | 3.5 |
| | MCZ 6594 | 1 | 8 | 30 | 3.8 |
| *Merychippus* | CMNH 26032 | — | 18 | 56 | 3.1 |
| *Equus* | Pony | (34) | l. 35, r. 33 | 83 | 2.4 |
| | I | — | 49 | 108 | 2.2 |
| | II | 34 | 41 | 110 | 2.7 |
| | III | — | 44 | 113 | 2.5 |

The bulbi: cerebrum height ratio remained basically the same during the evolution from *Hyracotherium* to *Mesohippus*. Correspondingly, the structure of the frontal bone in the region which was later to contain the widest part of the frontal sinus did not change; only small-celled spongiosa intervenes between outer and inner plates of the *Mesohippus* frontal bone. Directly above the vault of the olfactory bulbs the bone is even absolutely thinner than in two of the three *Hyracotherium* specimens measured (the Yale specimen and one in Dr. H. E. Wood's collection). The anterior cerebrum, however, had in *Mesohippus* a somewhat steeper profile, with a low vertical part (fig. 2). Correspondingly, the septum between cerebrum and bulbi gained relatively more in depth (col. II) than the skull increased in height (col. III). While still a small and inconspicuous structure, its share in the skull height has become larger (col. IV; I may add here two approximate figures I obtained from the *Mesohippus* endocranial casts AMNH 9768 and MCZ 1811. I "replaced" the destroyed external facies of the frontal bone by laying over these brains a thin ruler, and measured downwards from this "skull roof". Septum depths

must have been about 10 and 12 mm., respectively, skull heights 42 and 45 mm., the ratios 4.2 and 3.8).

The one endocranial cast known of *Miohippus* revealed no noticeable progress in brain evolution over *Mesohippus*. Correspondingly, only cancellate tissue lay between the outer and inner plates of the frontal bones in *Miohippus*.

The *Parahippus* skull AMNH 14305, whose cerebral chamber has previously been described (Edinger 1948, p. 67), unfortunately lacks all intra-cranial structures anterior to the cerebrum. These were studied only in the MCZ skull and endocast 17878, Upper Lower Miocene in age. A considerable change was observed to have occurred in the topography of the olfactory bulbs since the Upper Oligocene. The upper vault of the bulbi was no longer close to the external surface of the skull roof. Above the bulbi the frontal bone was of considerable thickness. It contained in a coarse spongiosa large diploic spaces. A sinus was not developed, at least in this one representative of the genus *Parahippus*.

From an early member of the *Parahippus* group of species evolved *Merychippus*, the form which in our series of material showed the first sinus in the frontal bone. Within the genus *Merychippus* occurred important evolutionary changes. In the skull, the elongation of the muzzle began, high-crowned teeth developed, and the cerebrum assumed a modern appearance.

Up to the *Parahippus* stage, the equid cerebrum was more or less egg-shaped, with a low slope at its tapering anterior extremity. In both Middle and Upper Miocene *Merychippus*, the trend towards the sub-quadrangular shape seen in most *Equus* cerebra became manifest in broadened frontal lobes which, vaulting antero-dorsally, developed a definite anterior facies.

In the Middle Miocene, olfactory bulbs could still reach high up in the skull. They did in the specimen shown fig. 4; the frontal bone was only 5 mm. thick above the bulbi. On the other hand, a *Merychippus* endocranial cast of the same age (Chicago Natural History Museum no. P.26032) has the vault of the bulbi about 22 mm. lower than that of the cerebrum. The incomplete Upper Miocene cranium described above suggests an intermediate condition viz., 10 mm. difference. The Upper Miocene natural cast AMNH 8105, while not containing the bulbi, shows the anterior profile of the cerebrum rising steeply from the impression of the ethmoidal windows.

Certainly in *Merychippus* generally the cerebrum, and particularly the frontal lobes, rose to far greater height within the skull than the bulbi. One might say that, in a sense, the antero-dorsal bulge of the cerebrum lifted the tabula externa up and away from the tabula in-

terna in the anterior part of the frontal bone. The inner plate now roofs ethmoidal chambers which do not continue the axis of the cerebral chambers, but lie on a lower level; it roofs ethmoidal windows along an inferior region of the cerebrum. The bulbi have, so-to-speak, evacuated the space anterior to the upper regions of the cerebrum. Between the tabula externa, which roofs the skull, and the tabula interna, which roofs, clings to, and is shaped by the brain, a space has evolved which has no function whatever. Bone substance, however, develops only under static or mechanical demand (Weidenreich 1924, p. 57). We have noted that the frontal bone spongiosa was loosened in *Parahippus*; the non-functional spaces between its osseous substance were larger than in the Oligocene Equidae, but still occupied by bone marrow. Weidenreich's reasoning led him to believe that there is, in principle, no contrast between diploic spaces and the pneumatic sinuses of the skull (1924, p 73); the latter are only larger (1924, p. 74). The history of the equid frontal bone shows that this is true. In the transition from *Parahippus* to *Merychippus* a diploic area became a sinus. With the vaulting of the anterior cerebrum in *Merychippus*, there originated within each frontal bone a larger superfluous area. The spongiosa was withdrawn. The empty space was walled off against surrounding diploë by the lamellar compacta whose smooth surfaces in our *Merychippus* specimens have been described above. These compacta walls, the typical lining of pneumatic intra-cranial spaces, show that the empty areas were air-filled; connection with the respiratory tract had been established, and the Equidae had acquired paranasal sinuses in the frontal bones.

I have not studied the skull interior of the evolutionary stages between *Merychippus*, in which at least a pair of dorsolateral frontal sinuses was developed, and *Equus*, in which the site of this original equid frontal sinus is the region of greatest depth and breadth of much enlarged, medially almost meeting sinuses. Of the intermediate stages of horse evolution, however, a number of endocranial casts have been studied. Certain trends observed in post-Miocene brain evolution were bound to further remove from each other the tabulae interna and externa of the frontal bone. Maximum cerebral height, which in earlier phases had increased at a slower rate than length and breadth, now gained relatively more than the other diameters. Frontal lobe vaulting increased, so that cerebral height gained anteriorly even more than posteriorly. The ratio of olfactory bulb height to maximum cerebral height, which had been 1:1.5 in *Eohippus*, was found to have fallen to 1:2.8 in one Pleistocene and two Recent *Equus*, and to 1:3.0 in a Shetland pony. Thus today the inner plate of the equid frontal bone has to reach far down into the skull to framet he ethmoidal window (see

table, col. II; "Equus III" is the no. II specimen of my 1948 paper). The proportion between the depth of the frontal bone at the ethmoidal window and total skull height has fallen almost to half that in *Hyracotherium*, viz., an average of 1: 2,45 (col. IV). That is, medially and paramedially in this plane the frontal bone occupies two-fifths of the height of the large *Equus* skull, and laterally much more.

In the brain, the height increase of the frontal lobe was accompanied by considerable increase in breadth. Average maximum cerebral breadth has about doubled from *Mesohippus* to *Equus*, but average frontal lobe breadth became almost threefold. Nothing comparable happened to the olfactory bulbs. Their breadth increase corresponded rather to that of the posterior cerebral regions, while the greater breadth increase of the anterior cerebrum widened the anterior cranium. Thus occurred the discrepancies between inner and outer plates of the frontal bone which we have described, in the first chapter, as the main region of the frontal sinus. In *Hyracotherium* the lateral wall of the bulbus chamber consisted of inner *and* outer plate of the frontal bone. In *Mesohippus*, too, the lateral wall of the bulbus chamber was median orbit wall. In *Merychippus* (fig. 4) and in *Equus* there is a gap between the tabula interna protecting the bulbus olfactorius and the tabula externa protecting the bulbus oculi; and this gap is pneumatized.

The writer now feels obliged to make a paleontologist's apology. As usual, the number of fossil specimens on which this study is based cannot be compared to those the veterinarians have used to describe the frontal sinus of *Equus*. Of course, fossil equid skulls which happen to be broken or sawed in such a way as to lay open internal structure of the frontal bone are — the phrase is particularly appropriate — few and far between. I admit that the fossil material at hand does not even disclose the full extent of the frontal sinus in the one form of which all available details were described, *Merychippus*. Only the posterior sinus region is represented in our material of this genus. Variation within the sinus is shown, as the sinus reaches farther back over the cerebrum in an Upper Miocene than in a Middle Miocene specimen.

The differences recorded between the frontal bones of the different genera in the ancestral series of the horse, however, appear greater and more significant than the frontal bone and sinus variations of living horses.

The material showing these different evolutionary phases has been objectively described in section III, 1. The phases have been interpreted in the present section as they appear to one who may be prejudiced through having previously studied in detail, of all evolutionary changes in the phylogeny of the Equidae, only those of the brain.

We must therefore now consider the general interpretations which comparative anatomists have given to the occurrence of frontal sinuses. These neozoologists, too, are handicapped; for none has ever traced the actual evolution of a sinus; they derive their ideas from conditions existing today.

## IV. CAUSES OF FRONTAL SINUS FORMATION

### 1. Theories

Frontal sinus formation is related to body size. In every ontogenetic development, and in at least the Equidae in post-Miocene phylogeny, the larger the skull becomes the greater are the areas invaded by air. However, this general principle is not all-explanatory. It cannot explain why the Equidae had to reach *Merychippus* size before developing frontal sinuses. Extant ungulates far smaller than *Merychippus* (and even the hyrax) have frontal sinuses. Pneumatization is more extensive in sheep and oxen than in deer of corresponding size. This difference is at least in part related to the fact that antlers are only attached to, but horns enlarge the skull, and the frontal bone in particular. Sectioned ruminant skulls such as seen in figs. 7C and 26 suggest that the horns are not the reason for the occurrence of the frontal sinus, but are pneumatized by the extension into them of sinuses already formed in the skull proper (this is the actual process in ruminant ontogeny). Large frontal sinuses develop in skulls with no superstructures at all — for example, the horse skull.

Pneumatization of superstructures, of course, makes them lighter. Sinuses have been believed to develop with the purpose of enlarging the skull without weight increase, so that the skull can retain a proper proportion to a large body and can accommodate the attachment of large muscles. Many an external feature, such as a vaulted calvarium, has been attributed to this supposed activity and purpose of sinuses — that is, to the air which fills it. Even the position of the eye has been regarded as influenced by such intra-cranial air. The orbit of the fossil equid *Hypohippus* is in a relatively low position "owing to the development of large frontal sinuses", according to Scott (1895, p. 97; see our p. 484). Actually, the position of the orbit is one of the several primitive features which *Hypohippus* had retained from its ancestors.

Paranasal sinuses are widely believed to have an olfactory function — to develop particularly in macrosmatic mammals, providing additional olfactory surface; but they never contain olfactory epithelium. Because in many mammals turbinal scrolls come to be lodged in the

sphenoidal sinus, accommodation of such plates has been regarded as the primary significance of all pneumatic chambers; empty sinuses were seen as a secondary condition, due to reduction of the olfactory apparatus. One theory not only explained the occurrence of sinuses but also accounted for the fact that they enlarge during ontogeny; the gradual bending of the turbinal lamellae was supposed to compress and narrow certain arteries so that the bone marrow, insufficiently nourished, atrophies and gradually disappears, leaving empty spaces within the bones. Further, sinuses have been thought to have an auxiliary function in respiration and to enlarge through the pressure of air blown inward at breathing. In the opinion of Weinert, frontal sinus formation is similar to that of bone crests, namely, always caused by muscles; muscles "tear the bones apart" (1926, p. 404). These theories can probably neither be proven nor disproved by Recent or fossil data; they are certainly not supported by any feature in the history of the Equidae.

No theory accounts for the extreme differences in occurrence, shape and size of frontal sinuses between the different forms of mammals except that of Weidenreich (1924; summarized and documented with further evidence 1941, and 1943 p. 164-166). Weidenreich's is an interpretation of paranasal sinuses which takes into account the other cranial structures; it has been tested by comparisons of different extant members of several groups of mammals; and it is, as will be seen, applicable to the actual story of a frontal sinus we have investigated, that in the Equidae.

According to Weidenreich, the paranasal sinuses have no active function but are passively created dead spaces. Their shape and size are determined by the disposition of the adjoining structures. These are, first of all, the basic components of the skull — osseous structures whose shape and size are determined by the organs they serve. They are the brain capsule and the three constituents of the face: orbits, nasal tunnel, and tooth apparatus with palate. A 5th structure is the skull surface; this not only unites the parts into a whole and serves as a base for the head musculature, but also develops weapons and other superstructures.

Rarely do these elements of the skull blend harmoniously with each other in the extant higher mammals. Mostly, they are incongruous. Consequently, there are within the skull spaces not occupied by its basic components.

An example of one kind of such spaces happens to be shown in section in our fig. 2, *Mesohippus*, and fig. 5, hippopotami. It is the area between the posterior slope of the braincase and the nuchal plane. Concurrent with the stress of the nuchal muscles, this space is filled

with cancellate bone (the same diploic space in *Equus* as in *Mesohippus*, but about eight times as thick antero-posteriorly).

If, however, unoccupied skull areas are not under stress, no bone develops to fill them. Their emptiness allows them to become invaded by air: to become paranasal sinuses. As to the role of size in pneumatization: "The larger the individual elements of the face, the greater, of course, is the incongruity between them and the larger the interspaces, that is to say, the sinus" (Weidenreich 1941, p. 389).

It follows that sinus formation is dependent not on one factor, but on several factors: the developmental trends of the different elements of the skull. It is clear that the driving forces at least of frontal sinus formation must have been differently distributed among the skull constituents in the different phylogenies of the living mammals. That pneumatization arose independently in each order was concluded even from the extant conditions (Paulli 1900, p. 562). Paleontology might be able to differentiate between the forces through which originated the basal spheno-palatine, the latero-basal maxillary, and the dorsal and lateral frontal sinuses, respectively. Speaking of the relations between frontal sinus, orbits and brain in the extant mammals, Weidenreich remarked that "the existence or absence of the frontal sinus apparently also depends on other factors difficult to analyze in each case" (1941, p. 389). Such analysis should be possible in ancestral series, where the actual evolution of a sinus can be traced from fossil ancestors through to the Recent condition.

## 2. Some extant cases

We are here concerned with the frontal sinus but should mention in passing that practically all living mammals have maxillary sinuses. It is the only sinus of the Insectivora and Chiroptera. Its very early appearance in pig and sheep embryos has suggested that the maxillary sinus is "a very old heirloom of the mammals" (Dennhardt 1903, p. 48). Perhaps "placentals" should be substituted for "mammals". No maxillary sinus has been found in monotremes and in some of the marsupials. It is reported to be absent, further, in the hippopotamus, whales, seacows, and pinnipeds. One is inclined to regard these latter cases as representing secondary conditions; but proof of this would have to come from fossil material.

Small bats have no pneumatization in their skull which is a tightly fitting capsule of the head organs; *Pteropus* has a maxillary sinus extending into the lacrimal bone and has no cavity in the frontal bone. This is also the condition in the Insectivora and the majority of rodents. The lack of pneumatization in sirenian skulls may appear as

a special case, due to their pachyostosis; giant size does not change the condition — Brandt's classic on *Rhytina* repeatedly stresses the fact that these giants had neither frontal nor maxillary sinuses (1846, p. 32; 1861-69, p. 40). However, the Pinnipedia too, in skulls otherwise similar to those of the Fissipedia, lack pneumatic spaces, as do the Cetacea. The latter case is interesting with regard to the relation between high cerebral hemispheres and frontal sinus which we believe to have observed in the Equidae. Whale brains are almost spherical; but there is no frontal sinus. This goes to show that a feature related to sinus formation in one phylogeny has no effect in another; also, that some cases remain obscure if one tries to understand the pneumatization conditions of all the living mammals without knowing the evolutionary history of their frontal bone region.

Man, with a higher brain than the apes, has smaller frontal sinuses: his eyes are closer to the brain. The discrepancies between inner and outer plate of the apes' frontal bone further depend upon size and position of a superstructure lost in man, the torus supraorbitalis (Weidenreich 1924, p. 72). The paragon of a pneumatized superstructure is the dome of the elephant's head. Its surface serves the mighty nuchal and trunk muscles; in this case the major force driving apart inner and outer plates is — it all happens in extra-uterine ontogeny — expansion of the skull surface (Weidenreich 1924, p. 67). In Cavicornia horn formation lifts up the tabula externa far beyond the horn base region (figs. 7 C and 26). The ox skull, comparable, except for its characteristic superstructures, to the horse skull, has far larger frontal sinuses. However, the high layer of air cells in the frontal bones of pigs, too, continues — as in oxen — into the parietal and occipital bones. The pig condition is considered by Weidenreich (1924, p. 68) as parallel to that of the elephant; nuchal musculature, elongated burrowing muzzle and tusks require abutments which the braincase cannot provide without superstructures.

The pigmy hippo (*Choeropsis*) also has large frontal sinuses (fig. 5A), but those of the giant among the living Suina, *Hippopotamus*, are relatively much smaller. Weinert (1925, p. 267) has even declared that in *H. amphibius*, in contrast to *Choeropsis*, "Das Stirnbein . . .ist völlig massiv". This erroneous statement rested on the Milne Edwards figure reproduced in our fig. 5 B and on one skull investigated which must have been medio-sagitally sectioned like Milne Edwards' specimen. The latter author, too, found large sinuses in the pigmy and no trace of a sinus in the giant hippo (1868-1874, p. 51). The fact is that the sinuses of *Hippopotamus* cannot be seen in medio-sagittal skull sections, because they are lateral only (the hippo skull exhibits the condition suggested for *Merychippus* by our material). Paulli described

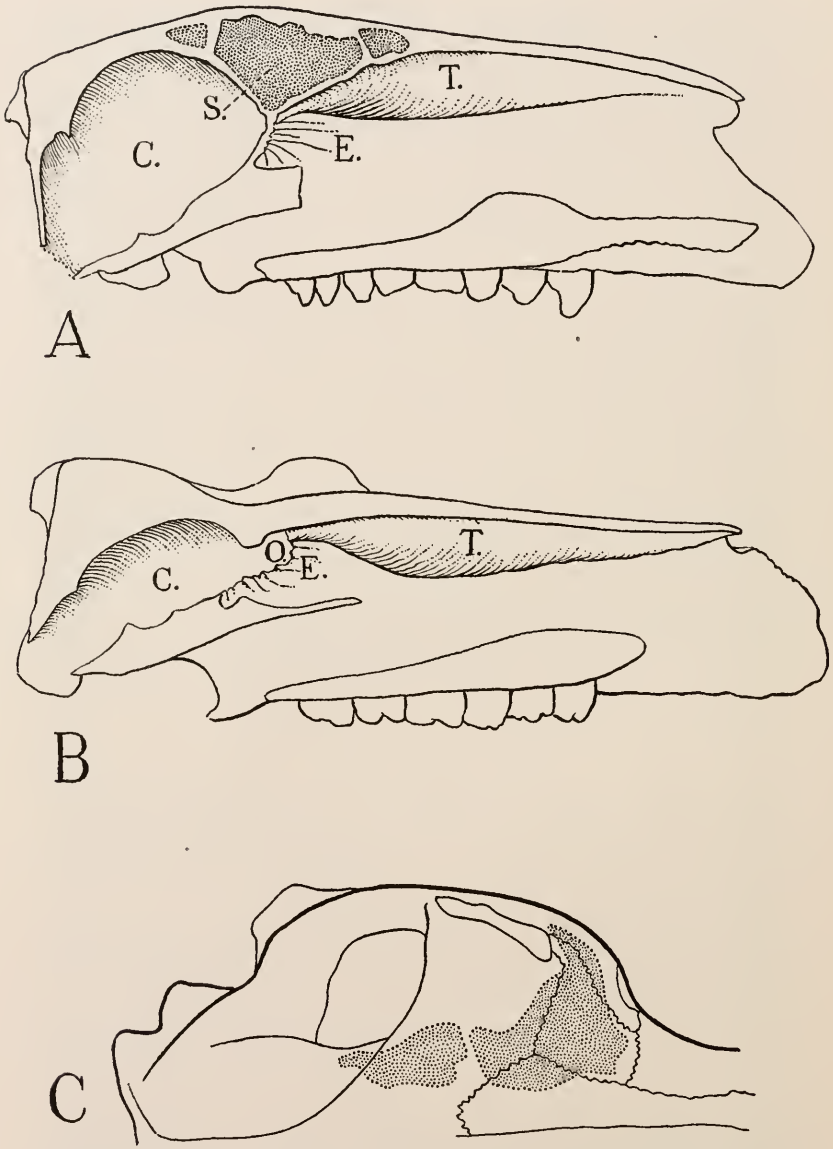



Fig. 5. A: *Choeropsis liberiensis.* Left half of skull. ⅓ nat. size. After Milne Edwards. B, C: *Hippopotamus amphibius.* B: as A, ⅙ nat. size. C: dorsal view of left half of skull, with position of fronto-parietal and fronto-naso-lacrimo-zygomatic sinuses stippled. After Paulli. Reduced.

and figured two compartments (1900, p. 202; our fig. 5 C). One pneumatizes the anterior region of the orbital plate of the frontal, and the lacrimal, zygomatic, nasal and nasoturbinal bones; the other compartment lies in the posterior part of the frontal and the anterior part of the parietal. The latter is seen in *H. amphibius* MCZ Dept. of Mammals no. 6119 which is the left half of a 735 mm.-long skull. This frontal sinus proper begins over the anterior slope of the cerebral chamber very close to the olfactory window, is widest alongside the olfactory bulb chamber, has two diverticula laterad into the posterior region of the orbit roof, and a foreward diverticulum which makes its total length 180 mm. Paulli's specimen seems to have lacked these pockets; still, his repeated "very small" is true also of the sinus in our specimen if it is compared with, e.g., a horse, for in this hippo the frontal sinus extends nowhere nearer to the median plane than 25 mm. Thus it was separated from its opposite not by a septum, but by an unpneumatized region with a minimum breadth of 50 mm.; the region is occupied by rather loose cancellate bone. — As Paulli (loc.cit.) stresses "the extraordinarily small extent of pneumatization in *Hippopotamus*", one is reminded of the absence of sinuses in the aquatic orders of mammals; a relation between non-pneumatization and life in the water is suggested. This, however, cannot be the cause of the difference between *Choeropsis* and *Hippopotamus*, because both lead the same amphibious life. Quite a different explanation of the more extensive pneumatization in the smaller form is indicated by Milne Edwards' two sectioned skulls (our figs. 5 A and B) and his description of their endocranial casts. Comparing the two brain forms, he found that the most striking difference between them is in the olfactory bulbs: "vertical" in *Choeropsis*, in *Hippopotamus* "long" and much more voluminous (loc.cit., p. 52, 53). The bulbi lie along the lower front region of a rounded cerebrum in the short skull of the pigmy, whereas in the long skull of the large form long bulbi continue the oblique axis of the cerebral hemispheres; the MCZ skull shows how their chambers extend upward and come close to the tabula externa of the frontal bone. Another circumstance providing more space for a frontal sinus in the pigmy is its vaulted skull roof; this is flat in the large form, a depression between the huge tubular orbits. In consequence of these internal and dorsal surface differences between the two skulls, the thickness of the frontal bone between cerebrum and olfactory bulbs (as measured in Milne Edwards' pl. IV) is 42 mm. in the 310 mm.-long *Choeropsis* skull, but 32 mm. in the 652 mm.-long *Hippopotamus* skull. Only one-third of the cranial height, this cerebro-olfactory "septum" is not pneumatized in the larger form; one-half of the cranial height in the small form, it is fully pneumatized.

In another order, Carnivora, one finds a similar relation between position of olfactory bulb chambers and size of frontal sinus in the large Felidae described by Hopwood (1947). Hopwood's objects were skulls of the lion and skulls of similar size of two smaller forms, cheetah and leopard. These also are another example of the fact that sinus size can be independent of skull size. "The sinuses of the Cheetah are much greater than those of the Leopard. The largest is the frontal sinus" (Hopwood 1947, p. 369). The leopard agrees with the lion, and with the cat (p. 370). Other differences of the skull interior are "the different extent to which the face is bent down on the basicranial axis (least in the Leopard, greatest in the Cheetah), and the relative volume of the interior of the brain-case (least in the Lion, greatest in the Cheetah)" (p. 373). Hopwood's pl. VI, showing medio-sagitally sectioned skulls of the three forms, and pl. VII which shows their endocranial casts, illustrate these features. They further demonstrate that in the cheetah "the bending down of the face . . . has prevented any real shortening of the olfactory lobe" (the bulb) "and has carried it downward" (p. 374). Whatever the reason, the olfactory bulb chambers lie much deeper within the skull in cheetahs than in lions and leopards. Correspondingly, of two skulls of about equal length shown sectioned in Hopwood's pl. VI, the cheetah specimen has a frontal sinus just double the depth, paramedially, than the leopard specimen.

But Paulli, after his extensive survey (1900, p. 562), claimed to have found that within each order of mammals the extent of pneumatization in the adult is directly proportionate to the size of the animal! Obviously, this is too sweeping a statement. Concerning the order Carnivora, Paulli was mistaken in believing that the frontal bone is never pneumatized in either Viverridae or Mustelidae. Other authors have found the sinus in representatives of both families of small-sized carnivores (Weinert 1925, p. 257, 262; Anthony and Iliesco 1926), including the diminutive weasel (Allen 1882, p. 142; Zuckerkandl 1887, p. 46).

Absence of frontal sinuses in Mustelidae is also maintained by Weinert (1925, p. 257); and he reports the same condition in foxes (p. 259), while according to other authors the structure of the nasal and paranasal cavities of dog, fox and wolf are identical "to the smallest detail" (Zuckerkandl 1887, p. 48).

There are, I believe, two reasons why authors disagree on the presence of frontal sinuses in some Carnivora, all of which normally do have some air cavity within the frontal bone. One reason are the considerable differences between specimens, differences (1.) of skull structure within species such as "the dog", and (2.) of sinus structure within the lifetime of the individual. The second reason for the contradictory statements in the literature is con-

nected with the latter peculiarity of carnivores, and is only a matter of different nomenclature.

In general, turbinals are attached to the anterior and lower surfaces of the ethmoidal chamber walls; in some Carnivora they arise, in addition, from an anterior part of the dorsal surface. Thus the nasal organ with its dorso-posterior extremity can occupy an area which in general is a typical frontal sinus area — and at least in some of the carnivores the nasal organ, during its ontogenetic enlargement, expands into the sinus of the frontal bone. This process is described by Paulli, who studied the heads of 35 dogs of different ages (1900, p. 492, 563, and 3 figures on pl. XXVII: puppy, young dog, adult dog). The frontal sinus is not developed in the new-born, is still wholly empty in the four-week-old, and is gradually entered, through a gradually enlarging foramen, by a turbinal which gradually unfolds in an antero-basal sinus region, and later by the posterior tip of another scroll. In Paulli's diagrams of cross-sectioned skulls of a large and a small dog (figs. 4, 5), *Ursus* (fig. 8) and *Nasua* (fig. 10), one can see that even the invaded compartments of the sinuses remain empty to a large extent. Yet this is the condition frequently described, for example by Allen, as follows: "In the otter, the mink, the weasel, and the bear, the frontal sinuses are occupied by the ectoturbinals" (1882, p. 142); and it is the reason why some authors (e.g., Weinert) prefer to call the frontal bone cavity of some carnivores not a sinus, but a frontal bone niche. Certainly in the anatomy of the adult the communication between the invaded sinus and the nasal cavity is wide, not a narrow foramen; and its contents indeed function as part of the nasal organ. However, no anatomist denies the name sphenoidal sinus to the cavity on the opposite side of the ethmoidal chambers, which in numerous mammals fills with nasal scrolls. Further, besides having the same ontogenetic development, the invaded compartment of the frontal sinus is set off from the adjoining sinus compartments (where such are developed) in the general fashion of sinus partition. In the large dog skull no. 5215 (MCZ Mamm. Dept.) this most anterior compartment is limited posteriorly by a transverse septum projecting into the sinus from the entire periphery of the cavity; this septum frames a transverse window, whose "sill" lies directly anterior to the upper frame of the ethmoidal window. Behind this incomplete partition lies a large empty sinus in this large dog skull, and a smaller one in the pug skull no. 7300. Likewise, in *Viverra civetta*, "the posterior half of the frontal sinus overlies not only the olfactory bulbs but also the anterior part of the cerebral hemispheres" (Anthony and Iliesco 1926, p. 1009). Anthony and Iliesco's fig. 6 shows just such a sinus also in a 110 mm.-long *Meles taxus* skull. It follows that genuine frontal sinuses are a general character of the extant Carnivora fissipedia, large or small.

The more Recent material is compared, the more doubtful one becomes about the importance of general size in pneumatization. The matter might be less obscure if in comparing small with large forms one had distinguished between forms primitively small and dwarfed forms; and among the latter one should distinguish between skulls which are

miniatures of the standard size and those in which dwarfism is accompanied by features aberrant, often greatly aberrant, from the norm. It seems reasonable to assume that sinuses expand concomittant with evolutionary size increase but that their extent is not necessarily reduced when a specialized skull is reduced in size. In the pigmy hippo we have seen a case in which a dwarfed skull is even more pneumatized than the giant skull of the nearest relative. On the other hand, the frontal sinuses of large *Canis familiaris* such as the wolfhound are absent in dwarfed *Canis familiaris* if as aberrant as the Pekinese. This difference has been convincingly explained by Weidenreich (1941, p. 430–431). In the Pekinese the braincase is relatively so large that its surface provides an area sufficient for the attachment of the masticatory muscles. In large dogs the cranial surface must be enlarged by sagittal and nuchal crests and braced by postorbital processes, structures which provide space for pneumatization. The braincase, relatively small in large dogs, ends some distance behind eyes and tooth battery; the skull region in front of the anterior pole of the brain, "a special intermediary portion, which is completely missing in dwarf types and consists chiefly of the frontal sinus, joins the maxilla to the brain case" (Weidenreich 1941, p. 339; it is the naturally rounded roof of this region which in the literature is usually described as a domed forehead *due* to sinuses in the frontal bone). Weidenreich found the same contrast in the degree of pneumatization when he compared small with large Felidae, marmosets with Cercopithecidae, the pigmy *Pan paniscus* with *Pan schweinfurthi* — "wherever small types contrast to large ones" (loc. cit.).

As lap-dogs and pigmy chimpanzee can be regarded as dwarfs developed from the larger forms, these cases show that a frontal sinus can be lost, and why. On the other hand, the extant mammals do not and cannot reveal how their frontal sinus originated; as to the why of frontal sinus occurrence, our survey of some extant cases shows that many a special condition remains enigmatic under explanations based on comparative anatomy. These interpretations are mechanical, and they are reasonable. But it should be realized that they do not describe how the present-day condition actually arose. To a paleontologist, at least, it is clear why a possible explanation of frontal sinus occurrence and extent in one group will not explain the condition in another group. Today's conditions are, of course, the outcome of difference phyletic developments. Comparisons of the anatomy of one living mammal with another are not descriptions of evolutionary processes, while frequently the wording of such comparisons implies that they are. One example shall be quoted here, also because it adds descriptions of some more of the various extant conditions to those

given above. These remarks on the osteology of living ruminants follow in the Zittel-Woodward textbook (1925, p. 206) the statement that in *Bos* the parietals are pressed into the occipital surface. "With the expansion of the frontals is frequently united a considerable extension of the frontal sinus. The cancellated tissue is replaced by air-cells and the frontal region exhibits a pneumatic condition. In the antelope this peculiar formation of the frontal zone may be traced step by step in its development. While in certain gazelles the frontal bones are still furnished with osseous cancellated tissue . . . in others larger or smaller air cavities are present."

To trace step by step when and how a sinus actually evolved in the frontal zone one must study an ancestral series of mammals — that is, fossil material — in the opinion of the present writer, a paleontologist. The opposite opinion is held by Weinert. His survey of pneumatization in the extant mammals (1926) makes their frontal sinuses features of crucial importance in the study of their evolution. Weinert found one could "trace the ancestral connections in the animal kingdom by investigating their frontal sinuses" (p. 369; e.g., man can have evolved only from "sinus-bearing anthropoids", p. 385).

### 3. Some extinct cases

*Survey.* Paleontologists, unfortunately, have paid little attention to the occurrence or absence of pneumatization in Tertiary mammals. Frontal sinuses of many Pleistocene mammals are mentioned in the literature; but conditions in the Pleistocene will hardly teach more about sinus evolution than present-day conditions. While I have not made a systematic hunt for references to skull pneumatization, I have taken notes from the literature ever since I studied the phenomenon in Reptilia (1938). Mr. Bryan Patterson of the Chicago Natural History Museum, who has just now under way studies which will incidentally fill some of the gaps in our knowledge of ancient frontal sinuses, has most generously kept me informed on his findings and has given permission to use in the present paper his unpublished discoveries; he has, in addition, supplied me with references I had not come across myself. I realize that I must have overlooked some (or many) more references in literature. Nevertheless I believe that paranasal sinuses have been mentioned or described in only one or very few Tertiary genera from only some of the orders of mammals; even less are figured. Almost all the data reported below, culled from the literature or seen in specimens, are based on what chance breaks have revealed. With the data so poor, a survey of what is known seemed of

little use in our quest after frontal sinus origin. The review was undertaken for negative reasons rather than in the expectancy of positive results. Read in connection with my study of the Equidae, some interpretations in the paleontological literature seemed open to doubt. I could not agree that everything described as a frontal sinus really was one. For example, frontal sinuses in fossil Equidae are twice mentioned in the literature; actually, the cavity in question is the olfactory bulb chamber in one case (see p. 442), the cerebral chamber in the other case (p. 484). Interpretation of cavities sometimes appears to be founded more on the author's awareness of conditions in Recent skulls than on what is seen in the fossil. Study of non-equid early Tertiary specimens had to supplement the study of the controversial literature. Positive results as to the main theme of the present paper were incidentally obtained; e.g., relatively late acquisition of a frontal sinus was not a phenomenon particular to the Equidae.

*Haplolambda.* Our review begins with a postscript. As the present paper was being finished, a letter from Mr. Patterson reported his discovery of a frontal sinus in *Haplolambda*, Upper Paleocene pantodont. Mr. Patterson sent me a sketch showing the cranium sectioned in the midsagittal plane. Almost half of the section consists of the enormously thick cranial roof. The sinus invades only an anterior portion of the lower half of the roof. It lies above the large olfactory bulb chamber and has a posterad diverticle over the anterior slope of the cerebral chamber. In another *Haplolambda* specimen Mr. Patterson found this sinus continued forward in the frontal bone at least as far as the postorbital process, which is invaded by the sinus. This is the oldest case of pneumatization we know of. According to Mr. Patterson's estimate, the skull to which the sectioned cranium belongs was ± 380 mm. long. The animal had been a giant among the Paleocene mammals which were, in general, small.

*Dorudontidae.* The spaces quoted as cetacean frontal sinuses since Stromer's (1903, 1908) description of Middle Eocene endocasts are, in my opinion, not paranasal but nasal cavities. The surface of the casts is fluted as are only casts of cavities containing turbinals. Actually, Stromer himself described the "sinus frontales" as "mit Nasenmuscheln gefüllte Hohlräume" (1908, p. 118). Similarly, Kellogg writes (1936, p. 200): "The longitudinal grooves on the dorsal surface of the frontal sinus mark the position of the inner chambers which are enclosed by the scroll-like ethmoturbinals." It is true that turbinals can project into the frontal sinus (in macrosmatic mammals: Carniv-

ora, see p. 439) which otherwise, however, remains an empty space. A cavity "filled with nasal conchae", and anterior to the olfactory bulbs at that, is not a sinus.

One *Dorudon* endocast specimen, however, includes casts of paired lateral cavities whose surface is smooth (Stromer 1903, pl. X, fig. 2 and pl. XI, figs. 2, 3, "f"). Their position is immediately anterior to the orbit, their anterior end in the plane of the infraorbital foramen; medially they communicate with the nasal cavity. Stromer thought these cavities probably were nasoturbinal, but found their projection laterad, into the upper posterior part of the maxillary, "quite unexplainable" (1903, p. 74). Here was no doubt a pair of pneumatic spaces, rightly interpreted by Kellogg (1936, p. 215) as maxillary sinuses. Apparently skull pneumatization in the large Eocene whale was comparable to, yet less than that in the tiniest of living ungulates, *Tragulus*, whose only sinus lies in the maxillary, lacrimal and zygomatic bones (Paulli 1900, p. 210, 246). For posteriorly in the Eocene archaeocet skull, notwithstanding the presence of a sagittal crest and conspicuous thickness of the roof bones, there was no pneumatization. The parietal, which roofs the brain, is shown in the intertemporal region anterior to the cerebrum in Kellogg's cross section of a *Zygorhiza* skull (1936, fig. 31 b). Excepting the canals for the ophthalmic nerves, there is no cavity in the 74 mm.-high and similarly broad bone above the olfactory peduncles. The frontal bone mass which more anteriorly overlies the long peduncles is described by Stromer as "innen fein spongiös" (1908, p. 116; pl. V, fig. 13). Cetaceans presumably never developed a frontal sinus. The fate of the maxillary sinus is not known except that today it has disappeared; Stromer searched in vain for a similar cavity in *Balaenoptera* (and in *Phoca;* 1903, p. 74).

*Canidae.* In *Pseudocynodictis,* whose described Middle Oligocene skulls are 89-92 mm. long, "there are no frontal sinuses" (Scott and Jepsen 1936, p. 84; also Scott 1898 b, p. 370). *P. gregarius* AMNH 1408 distinctly shows that there is no cavity whatever within the frontal bone over and forward from the anterior poles of the cerebral hemispheres. Great significance has been attributed to this condition. Scott, discussing the probable relationships of *Pseudocynodictis* (then called *Cynodictis*) with other Canidae, regarded as "certainly a suggestive fact that *Cynodictis,* like the foxes, is devoid of any frontal sinus, while all the other American genera, from *Daphoenus* onward, have well-marked sinuses, as the wolves" (1898 b, p. 404; cf. our p. 438). In the 1936, revised description of *Pseudocynodictis,* the absence of frontal sinuses still appeared important enough to be noted as "a difference from *Daphoenus* which, in this respect at least, agrees with

Huxley's thooid division of the Canidae, while *Pseudocynodictis* agrees with the alopecids, or foxes" (p. 84).

*Daphoenus*, a contemporary of *Pseudocynodictus* with skulls 1½ times as long, actually may not have had the "large frontal sinuses" recorded by Scott in 1898 (b, p. 332, 410). According to Scott and Jepsen 1936 (p. 58), "None of the available skulls is so broken as to expose the sinuses, but the convexities of the forehead seem to indicate their presence, though those convexities are not a sure proof of the existence of frontal sinuses, as *Urocyon* demonstrates" (a fox). At the Chicago Natural History Museum I have seen the endocast specimen on which Moodie based a description and figure of the frontal sinuses in *Daphoenus* (1916, p. 142-143, fig. 3). Moodie labelled "sinus frontales" three pairs of low and narrow longitudinal endocasts extending forward from the dorso-anterior end of the cerebral chamber cast. The middle pair, for example, is 19 mm. long, and the greatest breadth of each member — in the middle of its length — is 4 mm. Obviously, these casts were molded in narrow turbinal scrolls. A similarly low, channeled endocast is seen in this position, i.e. reaching back over the olfactory bulb chamber, in the indeterminable Oligocene canid endocast specimen AMNH 8767. Thus in such larger Middle Oligocene Canidae as *Daphoenus*, the nasal apparatus extended dorso-posterad as in Recent dogs, and one can reasonably assume that the low space into which the extensions protruded was pre-formed as a frontal sinus. Moodie believed that *Daphoenus* had a large sinus, "singularly like the frontal sinus of the modern dog", because he assumed that "the posterior superior portion of the cavities has been lost". Actually, however, the specimen is a complete endocast.

Large frontal sinuses above the braincase were present in later and larger Canidae, such as a Miocene *Amphicyon* (Patterson, personal communication) and a Pliocene *Pliogulo* (a form with a 230 mm.-long skull — White 1941, p. 67).

*Merycoidodontidae*. I have noted (1948, p. 60-61) that *Merycoidodon* and other Middle Oligocene artiodactyls had, like the contemporary *Mesohippus*, the olfactory bulbs in a high position anterior to the cerebrum. Scott has shown this condition in still another White River artiodactyl, *Stibarus* (1940, pl. XXXVI, fig. 2). The specimen graphically illustrates the relation of dorsal frontal sinuses to brain shape. It is a muzzle lacking the bones posteriorly so that there are exposed the natural endocasts of the anterior cerebral, the ethmoidal, and some of the turbinate cavities. In the side view, the dorsal surface of these casts and the preserved nasal bone form practically one line;

there was no room in the roof part of the frontals in which a sinus could have developed.

In *Merycoidodon* (*Oreodon*), Moodie (1922, p. 366-367) found latero-dorsal "Sacculations of the sinus maxillaris superior", and they are shown in his fig. 21, a dorsal view of his specimen. These pneumatic compartments are indeed not what is usually termed maxillary sinus, but a pneumatic area which in all studies of adult *Equus, Bos,* etc. is described with the frontal sinus, with which it is confluent. The ontogenetic stories reported p. 419 suggest that this anterior space develops before the cranial sinus. It is the pneumatization of the orbit walls. Many *Merycoidodon* specimens show its endocasts; MCZ 17397 shows them particularly well. There were lateral sets of cavities, or compartments of a sinus. This sinus was in great part in the frontal bone, namely, in the pars orbitalis ossis frontalis. The postero-lateral edge of the most posterior compartment protrudes somewhat into the insertion of the post-orbital bar; in contrast to *Mesohippus,* this bar is in *Merycoidodon* a voluminous structure proximally, and with its more slender distal part it closes the orbit which in *Mesohippus* is still open posteriorly. Compared with the slim skull of *Mesohippus,* the thick orbit roof and zygomatic process appear like "superstructures" in the broad, "piglike" *Merycoidodon* skull. Their pneumatization, incidentally, is similar even in details to that in the living *Capreolus* (Paulli 1900, fig. 30-31, p. 220-221).

A frontal sinus proper, in the middle roof region, was not developed in *Merycoidodon.* Moodie believed that in his specimen "frontal sinuses" had been present and that "we have the bulbs exposed in *Oredon gracilis* because the sinuses have been broken away." However, nothing is broken away from the specimen studied by Moodie — except bone, of course —. Mr. Patterson has kindly studied with me this specimen, and I have seen many other endocasts as well as many broken and sectioned skulls of *Merycoidodon;* the MCZ alone has seven skulls of *M. gracilis* and *affinis* broken across the ethmoidal or the cerebral chambers. There is never a sinus in the roof of either of these chambers; always cancellate bone tissue occupies the low space between inner and outer plates of the roof portion of the frontal bone. Occasionally spongiosa cells combine to form a larger cell — whose endocast, however, can be seen to be criss-crossed with bone laminae. It must have been such cell-clusters of which Moodie wrote: "A group of small cavities, just anterior to the brain are, doubtless, all divisions of the frontal sinus" (1922, p. 140), in his description of an endocast he believed to be *Merycochoerus* (1916, p. 135-141, fig. 1-4; 1922, fig. 17). However, Mr. Patterson assured me that no such matrix, no such natural endocasts are found in the Miocene and that Moodie's

"*Merycochoerus*" specimen appears to be another White River Oligocene *Merycoidodon*, probably *M. culbertsoni*.

In one *Merycoidodon* only have I seen a cavity large enough to be regarded as an incipient frontal sinus proper. In *M. gracilis* MCZ 16272 the frontal bone is chipped off dorsally in the anterior brain region, but was left in situ laterally. Here is seen the endocast of a small cavity which is posterior to the cavity in the orbit roof and separated from it by a bone wall. In the dorsal view which this specimen exhibits, the cavity has the shape of a triangle; the 4 mm.-long, longitudinal "base" is lateral, in the outer cranial wall at the postorbital constriction; the 4 mm.-distant "apex" points mediad between cerebral and olfactory chambers, whose walls constitute the sides of the triangle. Thus the incipient frontal sinus proper of the Merycoidodontidae was in a position corresponding to that of the basal pockets of the *Equus* frontal sinus.

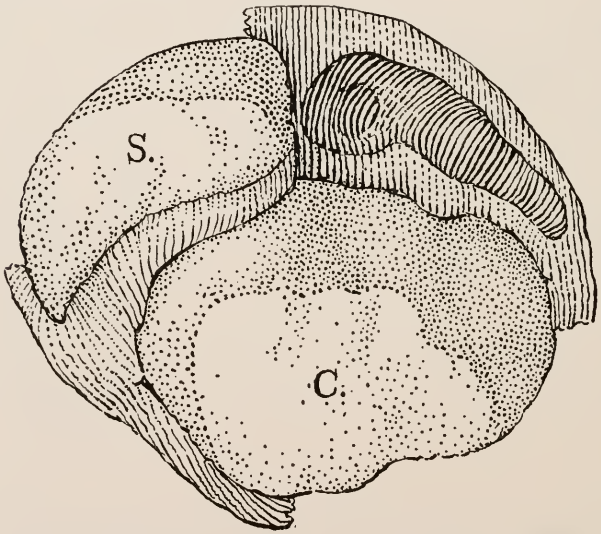



Fig. 6. *Eporeodon socialis* (M.C.Z. 5279). This anterior view of the posterior skull fragment shows the fragmentary frontal bones enclosing the natural endocasts (stippled) of the cerebral cavity and the right frontal sinus; the endocast of the left sinus was removed so that its posterior wall is seen. 2 x nat. size.

A radically changed condition was found in the Upper Oligocene direct descendant of *Merycoidodon*, *Eporeodon*. MCZ 5279 is a skull of the robust Upper Brulé *E. socialis*, in length (about 230 mm.) and

general bulk about double the size of *M. gracilis* skulls. It is broken in two along a transverse plane closely behind the anterior end of the cerebrum. Atop the frontal part of each cerebral hemisphere lies the endocast of a considerable frontal sinus (fig. 6). Both these endocasts can be easily detached, whereupon the typical smooth sinus walls are revealed. These sinuses were developed in an area of the frontal which in *Merycoidodon* was a low layer of cancellate bone.

The anterior surface of the *Eporeodon* frontal sinus has the shape of a drawn-out drop. Its proximal part, horizontal, is 8 mm. high. It tapers out latero-basad, where its curved end envelops laterally the upper part of the cerebral cavity; this lateral end region alone was the frontal sinus in the ancestral genus. The total anterior breadth of each sinus is 17 mm. The antero-posterior length is also 17 mm. The lateral walls converge, and the posterior end of each sinus is a circular posterad groove with a 3 mm.-diameter. Its position is noteworthy with regard to the relation of sinuses to superstructures. The sinus ends, inside the frontal bone, where on the outside the mediosagittal crest splits into the pair of temporal ridges. The area of the end-groove is marked on the dorsal skull surface by the angle which the posterior end of the temporal ridge forms with the median suture of the frontals. The median septum sinuum frontalium increases considerably in breadth as it approaches the end of the sinus — and the external crests.

When one compares with this *Eporeodon* specimen corresponding cross sections of *Merycoidodon* skulls, the impression is that something has lifted the tabula externa ossis frontalis up and away from the braincase. Comparison of intact skulls of ancestor and descendant gives the explanation. The *M. gracilis* cranium roof is practically level; but in *E. socialis* the two sides rise toward the midline, which projects upward in a voluminous ridge — the sagittal crest, noted as sharply prominent and 57 mm. long even in a smaller individual of *E. socialis* (skull length 199 mm.; Thorpe 1931 a, p. 12, p. 19). The supra-cerebral sinuses, acquired in *Eporeodon*, anteriorly join, beyond incomplete septa, the lateral supra-orbital sinuses, acquired earlier; and medially there is now a pair of sinus compartments overlying the olfactory bulb chambers. These compartments are small in dorsal view, and they are presumably not deep; for in *Eporeodon* the cerebral "superior surface slopes gradually forward, not after the abrupt manner of the slope in the horse, but rather more like that of the pig" (Thorpe 1931b, p. 194).

It should perhaps be noted that the condition here described of *Eporeodon* is a supplement to Thorpe's classic on the Merycoidodontidae. Its chapter "Sinus paranasales" only repeats Moodie's descrip-

tions, because Thorpe believed that "the general pattern is the same in all of them" (viz., the mercoidodont genera; 1937, p. 269).

*Protoceras.* Together with *Eporeodon socialis* lived *Protoceras,* whose males were the most-horned of ruminants. From skulls similar to large *Eporeodon* skulls in length (250 mm.) there projected, besides a thick sagittal crest, five pairs of bony protuberances. To judge from the literature, none of the paired superstructures was pneumatized. Two of them were enlargements of the frontal bones. Marsh described the frontals of the male *Protoceras* as "massive bones" (1897, p. 169). Pneumatization of a small degree was discovered by Scott. The parietal crest is "cancellous internally and encloses a small sinus", and besides this one "There is a small frontal sinus" (1940, p. 571, 573).

*Archaeotherium.* In this huge, pig-like Middle Oligocene artiodactyl, on the other hand, Scott found large sinuses — "giving the convex shape of the forehead" — when he studied three particularly large skulls, 746–803 mm. long (1898 a, p. 280). In *Archaeotherium* generally, "sinuses extend through the whole length of the parietals and even invade the supraoccipital. . . . The frontal sinuses are large and seem to communicate with the parietals" (1940, p. 384). "The great frontal and parietal sinuses overlie the whole cerebral chamber" (1898 a, p. 287; 1940, p. 388–389). Indeed, as in pigs, they extend back over the entire brain; and their height equals that of the brain chamber in the medially sectioned cranium Princeton University no. 10908. A transverse break in another Princeton specimen (no. 12532) shows the oval of the sectioned cerebral chamber surmounted by another hollow structure, which is triangular in the section: a large, fully pneumatized sagittal crest.

*Edentata.* Certainly because it was G. G. Simpson who collected and studied South American early mammals, frontal sinuses are recorded from three of the orders represented in the Casamayoran, the first half of the Eocene in that continent — Edentata, Astropotheria, and Notoungulata. Of *Utaetus,* a Casamayoran dasypodid, Simpson reports that "as in other armadillos the anterior parts of the frontals contain extensive sinuses" (1948, p. 83).

*Astropotheria.* In a skull of the oldest of Astropotheria, *Trigonostylops,* Simpson found already present that characteristic of its descendants, a domed forehead — "the frontals themselves being markedly convex and inflated by large sinuses in at least their posterior part, which is all that is preserved of them on the skull roof" (1933 a,

p. 9). This skull is about 220 mm. long in Simpson's reconstruction (fig. 1). Its snout is not preserved. This is an unfortunate circumstance, because the muzzle shape of later Astropotheria skulls suggests that these heads had a proboscis; among Recent mammals, this is an element correlated with the highest degree of pneumatization. In the 590 mm.-long skull of the Lower Miocene *Astropotherium* described by Scott (1928, 1937), "The great dome of the forehead, caused by hypertrophied frontal sinuses" is a most conspicuous feature; "fractured specimens show that this highly characteristic dome is filled with a complicated system of communicating cells" (1937, p. 315, 317). Mr. Patterson found an enormous main cavity with irregular, incomplete septa.

*Toxodonta.* The four notoungulate genera whose frontal sinuses have been described are from four different stages of the Tertiary but unfortunately do not form an ancestral series. They represent four different families — which, however, all belong to the suborder Toxodonta (Simpson 1945, p. 126–128). The Upper Eocene *Rhyphodon* had a frontal sinus unusually large for a relatively small mammal of that period. The anterior region of its brain, too, has an unusual configuration. Simpson, comparing the brain of *Rhyphodon* (skull length about 230 mm.) with those of two Lower Eocene mammals, *Phenacodus* (skull length 237 mm.) and *Notostylops* (skull length about 115 mm.), found the brain portions arranged in similar fashion, "except that the olfactory bulbs are bent downward (they are overlain by large frontal sinuses absent in the other genera here described)" (1933b, p. 15). Skull superstructures — sagittal and lambdoid crests — were present in both these other genera; but inside the skull of both *Phenacodus* and *Notostylops*, the olfactory bulbs extend straightly forward anterior to the cerebrum and thus are roofed directly by the skull roof (see Simpson's fig. 3C, 1932, which shows the endocast in a sideview of the skull of *Notostylops*.) The bulbi of *Rhyphodon*, on the other hand, are peculiarly drawn out and down; their dorsal surface is in the same horizontal plane as the fissura rhinalis of the cerebrum, and half the cerebrum lies above this level. The relation between this brain form and the occurrence of a sinus above the bulbi seems, to me at least, obvious.

The Miocene *Homalodotherium* also has a large frontal sinus. The sinus is likewise present in *Rhynchippus* (Oligocene) and *Nesodon* (Miocene), but in these genera "it is smaller and situated more anteriorly" (Patterson 1937, p. 290). Corresponding are, I believe, the main differences between the brains of *Homalodotherium* and *Rhynchippus*, as noted by Patterson loc. cit.; in *H.*, the form with the

larger sinus, "the olfactory bulbs are greatly depressed . . . the anterior third of the cerebrum is greatly depressed".

It seems to me that the smallness and anterior situation of the frontal sinus in the Miocene *Nesodon* are also related to the position in the skull of the anterior brain regions — which in this case is obviously due to a peculiarity of the skull. "The basifacial axis is bent down on the basicranial . . . the cerebrum is inclined upward" (Patterson 1937, p. 282). Patterson's side view of the *Nesodon* brain (fig. 77) shows that here the bend is more anterior than in the cheetah (see p. 438), for in *Nesodon* the olfactory bulbs rise upward towards the skull roof. Their dorso-anterior vault is only 10 mm. below the dorsal vault of the cerebrum. Their position in the skull is so high that their ventro-anterior tip is on a level 54 mm. above the pituitary region of the brain stem. Such a brain directly suggests that in its capsule there cannot have been much of a frontal sinus (but there should have been much room for a sphenoidal sinus).

A large frontal sinus has recently been found in an early Oligocene notoungulate by Mr. Patterson. The specimen is an about 400 mm.-long skull of *Leontinia*. The sinus is 77 mm. long, and 25 mm. deep just off the midline. The case possibly parallels that of the elephant (p. 435), as in *Leontinia* "a high position of the nostril opening suggests the presence of an expanded muzzle or proboscis of some sort" (Romer 1945, p. 396).

*Uintatherium*. The cavities in the skull of the Dinocerata have, it seems, not been studied since the 1880s — at that time, however, by the then greatest paleontologists. To judge from the descriptions, there was very little pneumatization of the frontal bone in that archaic group of ungulates. Yet the Middle Eocene American genus, *Uintatherium*, was as large as a Recent African rhinoceros; and its skulls, 760–870 mm. long, had developed superstructures to the extreme of three pairs of horns plus a crest around the posterior and lateral margins of the cranium.

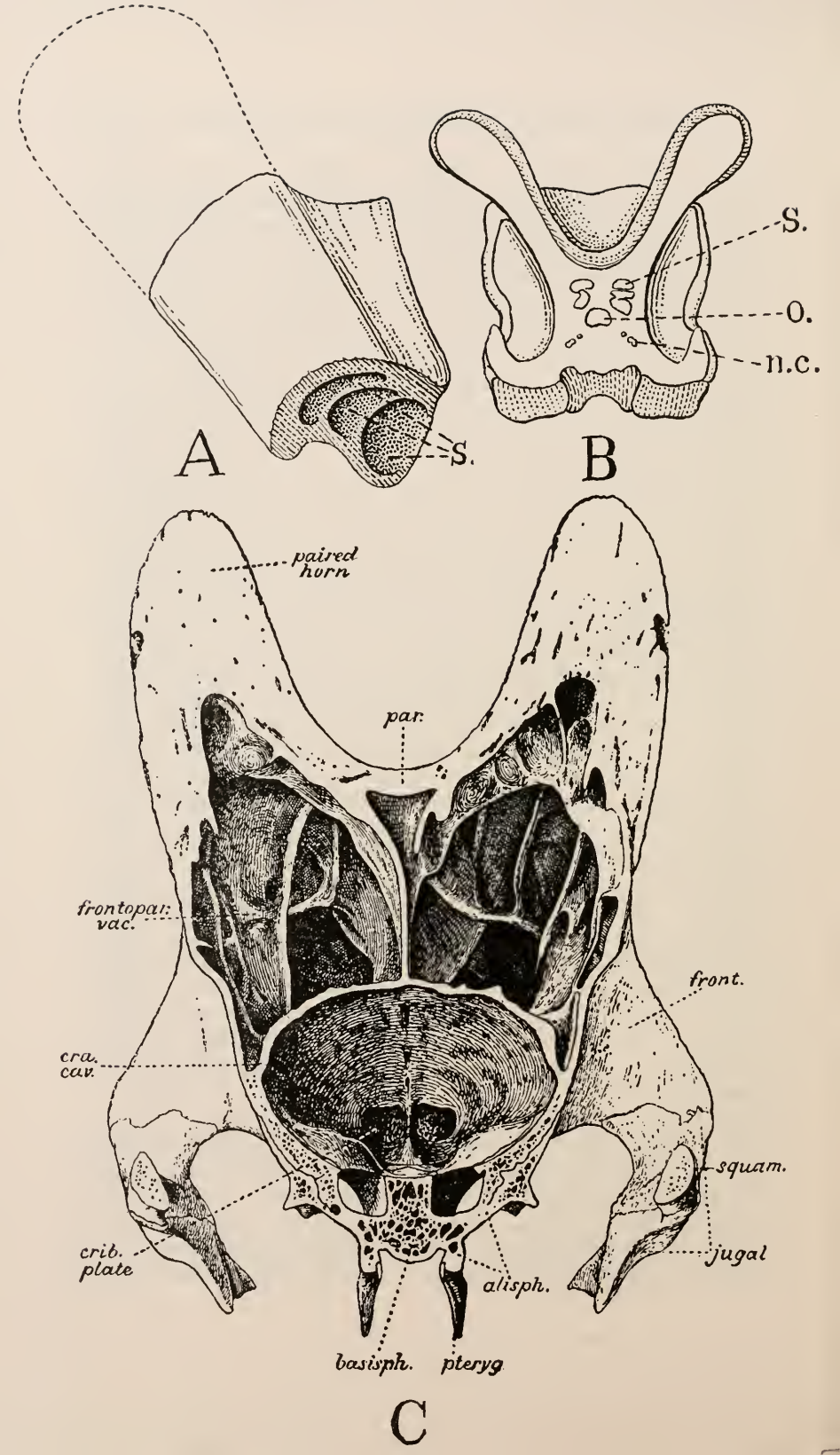
The smallest of the horns are swellings of the nasal bones, which are "thick and massive" (Marsh 1886, p. 12).

A large cone rises from each maxillary bone. "The maxillaries are massive . . . The cones are solid except at the base, which is usually perforated for the fang of the canine tusk" (Marsh 1876 a, p. 164). When Marsh later, in his Dinocerata monograph (1886), described those upper canines, he wrote that in dinoceras "the root extends upward into the base of the maxillary protuberance, or horn-core" (p. 43), whereas in tinoceras "the root, instead of being inserted in the base of the maxillary core, starts well back of it" (p. 46). However,

Marsh's "Dinoceras" and "Tinoceras" skulls belong to the same genus, viz., *Uintatherium*. The canine socket may in some individuals have projected into the cavity in the horn base (as do the molar sockets into the maxillary sinus of, e.g., horses), but that cavity is never identical with the canine socket. Its lower regions are seen in Marsh's four horizontally sectioned skulls of "Dinoceras" as well as "Tinoceras" (figs. 30–33: "cavity behind base of canine tusk"). Also in the "Tinoceras" skull YPM 11500 this maxillary sinus is separate from the canine socket. This sinus invaded the horn to a modest degree. For example, the maxillary horn YMP 1534 is 250 mm. long, and the endocast of a sinus seen in its base seems to have been hardly longer than the 25 mm. laid open in the specimen. The horn base, along which the horn broke from the skull, measures 130 mm. across, but the sinus in its center only 66 mm. Two smaller compartments lie along the medial side of this proximal surface of the horn. Among the "striking peculiarities" of a "Tinoceras ingens" skull Marsh mentions that the maxillary protuberances are "greatly excavated within, and below, as shown in fig. 191" (1886, p. 215); but even this horn has only one-fourth of its length pneumatized.

The largest horns of the uintatheres and the wide crest are formed by the parietal bones. Nevertheless, "These bones are thick and massive, but like the frontals are lightened somewhat by air cavities" (Marsh 1886, p. 18). Some pneumatization also of the temporal bone is reported in Marsh's '76 paper; "There are small air cells in the wall of the temporal fossa, both in the squamosal and parietals" (1876 a, p. 164). Whatever there was of cranial pneumatization must indeed have been restricted to latero-dorsal areas. No pneumatic spaces except the maxillary one are seen in Marsh's horizontally sectioned Dinocerata skulls (1886, fig. 30–33), nor in the median skull sections (ibid., figs. 34, 178). The latter figures show how thick was the massive roof of the small brain chamber. Osborn cites among characters shared by uintatheres and elephants "extensive air cavities in the skull" (1881, p. 26); according to his description of the *Uintatherium* skull (p. 43), however, the sinuses he saw are "in the sphenoidal and ethmoidal regions . . . The protuberances are solid above, but hollow at their bases."

The hollow in the parietal horn of the "Tinoceras ingens" mentioned above occupies only one-thirteenth of the length, according to Marsh's fig. 192 (1886) which shows this horn in side view. Among Cope's uintathere material was a fragment of a parietal horn in whose anterior aspect the base is seen to contain "three sinuses" (Cope 1884, p. 57 and pl. XXXIX; our fig. 7A). The "cavities in the cranial walls" of Marsh's cross-sectioned uintathere skull (1886, fig. 35; our fig. 7B)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are similarly subdivided. On the left side three, on the right side two compartments form a sinus, dorsal and lateral to the chamber which lodged the olfactory bulbs, in the otherwise massive frontal bone. These sinuses must have been continuous with the pockets in the parietal horn bases. Uintatheres thus appear to have had a lateral pair of narrow, tunnel-like, longitudinally (and perhaps also otherwise) subdivided fronto-parietal sinuses extending back from the nasal cavity, over the olfactory bulb chambers, to the base of each parietal horn.

It will be noted that none of the long bones of the Dinocerata has a medullary cavity. The inner structure of humerus and femur is described as "somewhat cancellated" (Marsh 1886, p. 91, 141), the distal long bones are "nearly, or quite solid" (ibid. p. 96, 142). This condition illustrates a general tendency to stoutness and heaviness of the skeleton in the uintatheres, a phenomenon which offers one possible explanation of frontal sinuses much smaller than in comparable living forms.

There is, of course, no living form similar to the uintatheres; but some comparison is possible between the uintathere skull and, for example, that of the giraffe, whose interior structure happens to be particularly well figured, by Ridewood (1904). *Camelopardalis* skulls are not quite as enormous as *Uintatherium* skulls, but they are very large (occipital condyle to premaxillary tip 650 mm. in three specimens I measured; *Uintatherium:* 760 mm.), and they do not have three horn pairs, but a pair of fronto-parietal horns plus a median frontal horn. In fig. 7C one is looking forwards into a giraffe skull obliquely sectioned down the front part of the paired horns. This section includes the summit of the fronto-parietal sinus, but not that of the horns; these are hollowed out for about one-third of their length. The section plane is more posterior than that of *Uintatherium;* it crosses not the olfactory but the cerebral chamber. The figure shows, beyond the anterad sloping roof of the cerebral chamber, the ethmoidal windows, and beyond these the cribriform plates: olfactory chambers not anterior, but baso-anterior to the cerebrum. In this respect *Camelopardalis* is as similar to *Equus* as *Uintatherium* to *Hyracotherium*. As regards the sinuses, the figure speaks for itself. Compared with those of

Fig. 7. A: *Uintatherium* (*Loxolophodon cornutum*). Fragment of right posterior horn, anterior view. ⅓ nat. size. After Cope. B: *Uintatherium* (*Dinoceras mirabile*). Proximal side of skull sectioned across olfactory chambers. ⅛ nat. size. After Marsh. C: *Camelopardalis* sp. This posterior view of a skull cut obliquely across the front part of the paired horns shows, below the frontal sinuses (fronto-parietal vacuities), the anterior part of the cerebral chambers (cranial cavities), their anterior limit: the ethmoidal windows, and anterior to these the olfactory chambers, with their anterior wall: the cribriform plate. 2/7 nat. size. After Ridewood.

*Uintatherium*, the frontal sinuses of the adult giraffe are enormous. They extend forward to below the median horn, and laterally they hollow out completely the postorbital bars (Ridewood 1904, fig. 7).

*Arsinoitherium.* Pneumatized horn cores are known in one genus of early Tertiary mammals. The only known representative of the subungulate order Embrithopoda, the huge *Arsinoitherium* of the Lower Oligocene, had the tabula externa lifted up on no less than two-thirds of the skull roof by the formation of two horn pairs — or, rather, a set of four horns. The members of each pair are fused medially and the two pairs are fused at their bases. The posterior, frontal bone horns of *A. zitteli* are 327–400 mm. long. The anterior pair, formed partly by the frontals, mostly by the nasals, sweep upward and forward beyond the limits of the skull proper. They are structures with lengths of 640–1094 mm. and a width across of their combined bases, stretching all across the skull, of 168–245 mm. (Andrews 1906, p. 69). "The great anterior horns consist of comparatively thin bony walls which are strengthened by a complex system of buttresses . . . The central portion is occupied by an enormous sinus, the walls . . . 0.5 to 1 cm thick in the adult, and much less in the young. The sinus occupies the bodies of the nasals and frontals and in the latter extends into the small supraorbital horns. Furthermore, it extends back into the parietal, and in the old animal even into the base of the lateral prominences of the lambdoidal crest. In the cranial region the sinus is more or less completely divided into right and left half by a median septum occupying the position of the suture between the parietals. Here the lower table of bone forming the actual wall of the braincase is very thin, while the upper table is greatly thickened". Although not accompanied by an illustration this description, more detailed in the original (Andrews 1906, p. 9), is a convincing record of genuine and extensive frontal sinuses.

There were present in *Arsinoitherium* not only the two obvious factors known to induce pneumatization, a giant skull (length to 800 mm.) and superstructures, but also a third factor contributed to the discrepancy between inner and outer plates of the frontal bone. The frontal region of the *A.* brain is so "prominent and rounded" (Andrews, p. 15) that its profile arches upward from the olfactory bulbs — a progressive feature as uncommon in the early Oligocene as are the hypsodont molars of this form. Measuring Andrews' side views of the *A. zitteli* type (pl. I) and its endocranial cast (text-fig. 5C), one finds that the posterior border of the posterior horns is in the same transverse plane as the anterior end of that part of the cerebrum whose dorsal surface is horizontal; that is, the tabula externa slopes upward just

where the tabula interna is inclined downward as it follows the slope of the anterior cerebral surface.

*Titanotheres.* A discussion of the titanotheres takes us back to the order with whose most common living representative this paper started — the Perissodactyla. Titanotheres, much like contemporary equoids in the early Eocene, became extinct when horses were in the beginning of the *Mesohippus* phase. In America they died out during the early Oligocene, when the Embrithopoda became extinct in Africa; as in that order, the last of the titanotheres were giant forms with paired superstructures on their large heads. Perhaps only a student of pneumatization can quite understand why the horns of the Oligocene titanotheres are referred to as "the so-called horns", "the horns, to call them so", etc. Of course a horn is, to quote Webster, "2. Any natural projection or excrescence from an animal, resembling or suggestive of a horn". Paleontologists must have too much in mind Webster's no. 1 definition, the hollow horn of Recent Cavicornia — and titanothere horns were practically solid, as were those of the uintatheres in a still earlier period of mammal history. Titanotheres (in contrast to uintatheres) are represented in American collections by a vast number of specimens. However, as far as I know, in a century of literature on the titanotheres only four authors have noticed pneumatic spaces in the skull, mentioning them incidentally. Those brief references to titanothere sinuses are confusing. Study of certain Upper Eocene and Lower Oligocene specimens showed conditions which appear to be different from those in all other mammals whose pneumatization is on record. When looking over the many hundred figures of titanothere skulls in Osborn's monograph (1929), one gets the impression that many incomplete specimens display breaks appropriate for sinus studies; but in almost all originals which I have examined the inner structure is hidden under a plaster coat. A study of pneumatization in titanotheres by means of serially sectioned skulls from the different groups is necessary to trace the whole, doubtlessly interesting story of frontal sinus evolution in the titanotheres — but that is beyond the scope of the present survey. So is likewise, I feel, the detailed account given below of the knowledge now at hand. However, the case of the titanotheres is one which adds considerably to the problems of frontal sinus evolution. This is by no means apparent from the previously published, scattered data. These call for correction and amplification.

Marsh (1876 b, p. 335) described the horns of *Menodus ingens* as formed by the maxillaries and containing "large air cavities in the base". Actually,

the horns are expansions of the nasal bones. The (lost) type specimen of *Megacerops coloradensis* Leidy consisted of the nasals with the horns, and breaks in many directions gave access to views of the internal structure. Leidy (1873, p. 239) found that "The nasals and contiguous bones are of great thickness, and as solid as those generally in the living Sirenians"; the horns "are large, dense, conical knobs".

Cope, too, described a horn as "a large osseous tuberosity, which consists of a mass of bone, . . . its base . . . not excavated by the anterior part of the frontal sinus" (1874, p. 491–492). This horn belonged to Cope's genus Symborodon, whose species Osborn (1929) has distributed to *Menodus* and *Brontotherium*. Cope's description of the general characters of the genus suggests considerable pneumatization of the skull proper. He calls "the large sinus common to the genus" a "huge cavity" (p. 481–482). This is described as a chamber on each side between the side walls of the long nasal fossa and the lateral skull walls. He makes two seemingly contradictory statements about the posterior topography of these sinuses; they lie in front of the olfactory bulbs (p. 482), they extend above and behind them (same page).

The sinuses along the nasal channel are not mentioned elsewhere in the literature, but Scott (1941), in his summary of the characters of the American Oligocene forms, wrote: "A system of numerous small communicating sinuses was developed around the brain-case, lightening the skull without loss of strength" (p. 874). In the detailed anatomy, however, Scott states that the frontals, the largest elements of the skull, "like the parietals, are very thick because of the cancellous bone, with which they are filled" (p. 884).

The fourth record of titanothere skull pneumatization I found in the literature is the only one showing sinuses in figures — in fact it consists mainly of fig. 254 in Osborn's monograph on the titanotheres (1929). Here are shown longitudinally and transversely sectioned skulls of genera far older than those in which frontal sinuses have been mentioned by Cope, Marsh and Scott. Besides pointing out the sinuses in the legend to fig. 254, Osborn has only occasionally mentioned the presence of sinuses in the figured Eocene titanotheres in the text of his monograph; I found no reference to the sinuses of Oligocene forms. The available data on pneumatization in the three figured Eocene genera will, therefore, be described here (I–III) and followed with my findings in some Oligocene specimens (IV).

I. The Middle Eocene *Limnohyops priscus* shows no sinuses in a cross section of the parietal bone region (Osborn's fig. 254B). The legend is not clear as to the presence of pneumatization in this tapir-sized species, in which the top of the cranium is slightly concave, and a skull 375 mm. long; "In this primitive form the sagittal crest has not expanded into a flattened cranial vertex, and hence this region is without any *large* cavities" (italics mine).

II. Osborn had a 415 mm.-long skull of the Middle Eocene, broad-headed *Palaeosyops* sectioned — medially in the cranial region, and transversely in about the middle of its anteroposterior extent. The

sections cannot be re-studied; they were made in the type of *P. leidyi* which is now an exhibition skeleton. In the cranium (Osborn's fig. 254 A1 = our fig. 12) the brain chamber occupies less than half the height. Thus the tabulae externa and interna are wide apart in the parietal and frontal bones. Osborn's legend to this figure notes "the cellular character of the expanded cranial vertex above the brain chamber". A large mass of bone lay above the brain. It was anteriorly, in its mid-height, invaded by a sinus which pneumatized about half of the dorso-ventral thickness of the frontal bone. Of course only the mid-plane configuration of this frontal sinus can be seen in the section. The sinus ended posteriorly over the anterior slope of the cerebral chamber. Two small bones are seen next to the skull roof, one below the other, about 32 and 36 mm., respectively, posterior to the transverse plane of the tip of the postorbital process; these are possibly fragments of an anterior sinus wall.

The transverse section through the right half of this skull (fig. 254 A2 = our fig. 13) was cut just behind the postorbital process and the last molar. The largest cavity in this section (not labelled) is the nasal tunnel. From its lateral wall thin plates variously extend into the lumen. These are remains of turbinates, and the small chamber which the dorsolateral ones enclose was presumably the cavity in the nasoturbinal. It is labelled "lateral ethmoid sinus" but obviously was nasal, not paranasal. Thick bone roofs the nasal chamber. It contains medially a small sinus (not labelled). This was probably the frontal sinus which the longitudinal section revealed in more posterior regions, narrowed and much flattened in the region of the cross section where it overlies the olfactory organ. Lateral to it a wider cavity is seen in the cross section, and this is labelled "frontal sinus".

Endocasts of this lateral postorbital sinus are present in *Palaeosyops robustus* AMNH nos. 1554 and 19234. The major piece of the latter specimen is an uncrushed cranium. This is about 220 mm. long, measured dorso-medially from the occiput to the irregular cross break which forms the anterior end of the fragment. The break is in the inter-orbital region. Along the break the whole interior of the skull is nasal chamber — that is, neither the dorsal nor the lateral sinuses extend so far forward. Backward from the break, for about 70 mm., the tabula externa ossis frontalis is lost in the lateral regions. This circumstance has revealed, to the right and left, beginning about 30 mm. behind the break, perfect endocasts of sinuses imbedded in thick diploë. Of course neither of the two endocasts is completely exposed; but their shapes suggest that very little is hidden under bone. Irregularly egg-shaped, the right and left sinuses are rather different in detail. Approximate breadth can be measured on the right sinus;

it is 20 mm., which was about one-seventh of the skull breadth in this region. This sinus is 41 mm. long. The left one extends farther forward, is 52 mm. long and up to 30. mm. high. The surface of the endocasts is quite smooth; these sinuses were not chambered. They had diverticula which were different in the right and left one, but each endocast has its most laterad projection near its anterior end. Comparison with other skulls (skulls whose lateral bones are preserved) shows that this anterior diverticulum projected into the proximal part of the postorbital process. The sinus did not reach forward into the roof of the orbit itself. Neither did it occupy the "strong median convexity near the fronto-parietal junction some distance behind the orbits" which Osborn mentions among the characters distinguishing *Palaeosyops* from *Limnohyops* (1929, p. 302). As seen in the uncrushed cranium here discussed, and likewise in Osborn's figures of *Palaeosyops* skulls and heads, the roof region he presumably was referring to is not an upward convexity; it is rather the rounded slope which connects the posterior, horizontal part of the skull roof with the lower, muzzle region containing the orbits. This is where, it seems, discrepancies occurred between the outer skull and the contained organ, so that pneumatic spaces developed. In contrast to the wide sinuses which large dogs have in the comparable region (see p. 440), those of the far larger *Palaeosyops* were restricted to the lateral margins of the skull. It is possible that this pair of small lateral sinuses near the anterior edges of the frontal bones was connected with the more median dorsal cranial sinus (fig. 12). However, both the specimens showing endocasts of the antero-lateral sinuses suggest that this cavity was a separate development. It is very similar to "Höhle $4^1$" in Paulli's *Tapirus* (1900, p. 183, fig. 2) which, however, is one of four paired cavities pneumatizing a considerable portion of the frontal bone.

The other specimen exhibiting a sinus endocast is AMNH 1554, the skull whose dorsal aspect is shown in Osborn's fig. 285, and whose left fronto-nasal junction was sectioned (Osborn's pl. XVI, A1 and A2; our fig. 14). The right side of this skull contains a sinus endocast very similar to those described above. The tapering ends of the endocast suggest that sinus length was little more than the exposed 28 mm. Maximum breadth is 29 mm., which is about one-tenth the breadth of the flattened skull roof in which the cast is imbedded. In this crushed specimen the sinus lies in the region above $M^3$ and $M^2$ and partly over the orbit.

The only reference to *Palaeosyops* sinuses I could find in the text of Osborn's monograph is, indeed: "a prominent convexity above the orbits covering a large frontal sinus". This feature is no. 2 in the

enumeration of the characteristics of the genus (p. 315). Characteristic no. 3 is: "rudimentary osseous horns which appear on the side of the face" — namely, as stated in an account of horn evolution in the titanotheres (p. 790), also "immediately above the orbits". Thus *Palaeosyops* is described as having had two swellings on each orbit roof, one pneumatized, the other not.

In order to save later students the trouble I had in finding either of these prominences (on *Palaeosyops* skulls, or the respective data in the labyrinthine monograph), I wish to state here that I found only one, a very slight, or no protuberance in the orbital region of the AMNH *Palaeosyops* skulls. The no. 2 feature of the list quoted above I have not found mentioned anywhere else in Osborn's text, nor is it pointed out in any of Osborn's figures. On the other hand, the horn rudiments of *Palaeosyops* play a large role in the monograph. Thus it is characteristic no. 2 which does not exist — or, rather, is identical with no. 3. This rudimentary horn, therefore, should be "covering a large frontal sinus". The sinus, we have seen, exists, although in a postorbital rather than supraorbital part of the frontal bone. As concerns the osseous convexity, it is apparent from Osborn's own descriptions that one can either not see it at all, or not see it as an incipient horn unless one's mind is preoccupied with the large horns developed by later titanotheres.

"Horns originate invariably above or slightly in front of the orbits, on the line of the nasofrontal suture" (p. 790; "at the junction of the frontals and parietals", p. 816, is a lapsus calami). However, in *P. robustus* AMNH 1554 most of the region marked "horn swelling" (fig. 285) is post-orbital; and the "horn swelling" of *P. robustus* AMNH 1580 is shown (fig. 286) on the medial half of the frontal bone — not above the orbit but above the nasal channel. The incipient horns further vary from "excessively rudimentary swellings which in their initial stages can hardly be detected" (p. 814) to the "distinctly rugose frontonasal horn swellings" listed as one of the characteristics of the species *P. robustus* (p. 331; also p. 790: "*Palaeosyops robustus* shows a rounded bony horn rudiment, which becomes quite conspicuous in aged individuals"). "Rudiments of horns are smooth and rounded" (p. 790) or, in "some very old males of *Palaeosyops* show . . . roughening of the outer tabula of the bone. (See Pl. XVI.)" (p. 266).

The figure Osborn is referring to is reproduced in our fig. 14. Even in that specimen roughening and protuberance can rather be felt than seen — but a description of what Osborn had in mind is found on p. 790 of this monograph: "bony exostoses or thickenings of the outer bony layer, with expansion of the cancelous tissue beneath". I can

sinuses (and also paranasal sinuses with each other). The opening might be due to post-mortem disturbance; but the area as a whole appears undisturbed, as its general structure is the same in the right and left skull halves. Turbinals in the parietal bone region, and lateral instead of median to sinuses, would be a very unusual condition. Backward extension of the nasal cavity can shift a large number of not find the tabula externa thickening, and wide expanses of cancellous bone are not restricted to this particular region of the *Palaeosyops* skull. On the other hand, it is this region — the region at the post-orbital process — in which the diploic area is interrupted by the imbedded sinus. The smooth surface, which Osborn's figure shows on the lower side of the frontal bone section (our fig. 14, arrows) roofed the anterior region of the sinus; the sinus endocast is still present on the sectioned and figured left side of this skull (but not as well preserved as that on the right side). Thus there was a topographical relation between the supposed horn rudiment and the dorso-lateral sinus of *Palaeosyops*. The relation was, however, of course not functional. The only specimen whose sinus was figured in the monograph (fig. 254 A 2 — our fig. 13) is the type of *P. leidyi* of which Osborn particularly notes "the absence of any horn rudiments" (p. 328).

To summarize: Pneumatic spaces in the voluminous roof of *Palaeosyops* skulls have been found up to now 1.) dorsally in the region of the anterior brain chamber and posterior nasal cavity, 2.) dorso-laterally at the transition from cranium to muzzle, immediately behind and possibly also over the orbits.

III. *Dolichorhinus* of the Upper Eocene had a long, slender skull. Extensive pneumatization was developed despite the fact that, excepting greater skull lengths, none of the features commonly regarded as inducing pneumatization is added in this phylum, compared with the Palaeosyopinae from whose base it developed. There is, in fact, a loss of one such feature, viz., robustness of the skull — for example, breadth across the zygomatic arches is in *Dolichorhinus* absolutely less than in *Palaeosyops*. The "relatively prominent supraorbital horn swellings on nasals" (Osborn 1929, p. 396) are almost invisible. The brain is in the longer head even more (as has been written of titanothere brains) "hidden away". The brain capsule occupies only one-seventh of the skull length, and at the highest vault of the cerebrum the heights of skull base, brain capsule and skull roof compare as 1 : 3 : 4. Such a negligible quantity as the *Dolichorhinus* brain cannot have actively contributed to sinus formation; but the incongruity between small brain capsule and large cranium is spec-

tacular. The *D. hyognathus* skull which Osborn's fig. 254 shows sectioned paramedially is very much like an *Equus caballus* skull in outlines and in length (550 mm.). However, its frontal sinus extends much farther back than that of horses. Pneumatization in *Dolichorhinus* was, further, much more extensive than it had been in *Palaeosyops*.

Osborn's interpretation of the large sinuses he discovered is seen in the lettering of his figure, which is reproduced in our fig. 15. His only comments were 1.) in the figure legend (p. 299), "showing . . . the elongate fronto-occipital sinus" and 2.) in the account of *Dolichorhinus* generic characters (p. 396), "space above brain chamber filled with large air sinuses". Osborn's figure of the left side portion of the sagittally sectioned skull does not show a "median section slightly to the right of the median plane". The section surfaces of both "halves" are to the left of the midsagittal plane. At the anterior end of the brain chamber, the cranium is about 40 mm. broad in the left and about 50 mm. in the right half. In the latter (our fig. 16), the section surface is not altogether plane but some matrix has come off, revealing in situ fragments of the septum sinuum frontalium. In these median and paramedian planes of the *Dolichorhinus* skull, bone of considerable thickness is seen only in very restricted areas. The floor and back wall of the brain chamber, and its roof only as far forward as the cerebellar chamber, consist of thick bone with spongy interior structure. The skull roof proper is relatively thin in this posterior region. It thickens slightly anterad. The nasal bones have the greatest dorso-ventral diameter among the portions of the outer skull roof; they contain some diploë, but no sinus (the line which in fig. 15 runs obliquely downward from the tip of the nasal bone represents the border of the matrix left within the skull). The matrix which has replaced the olfactory organ takes up by far the largest part of the section surfaces. It encloses scattered remains of the turbinate bones, particularly along the floor in front of the choanae. Remains of the most proximal turbinates, the delicate ethmoturbinates, are preserved in situ; they radiate forward and upward from the roof of the chamber which contained the olfactory bulbs (fig. 16, E — as in *Canis!*).

Immediately posterior to these ethmoturbinates there rises from the roof of the cerebral chamber a median and perpendicular plate: a fragment of a septum (fig. 16, se.) medially dividing a pneumatized region which, 70 mm. high, extends through the whole upper half of the cranium. This fragment is broadly anchored on the brain capsule; its lowest region is about 3 mm. thick, its maximum height and maximum length are 20 mm. Its anterior border appears to be the natural

that the septum sinuum frontalium was posteriorly attached to the perpendicular portion of the occipital bone. There is in this specimen no indication that the median septum continued upward and attached to the roof portion; if it did not in the living animal, this was an extremely odd condition for the large dorsal sinus compartment (S. 1 — the "Fronto-occipital sinus (sagittal)" of Osborn's figure). Further compartments within the wide pneumatic area are indicated by sectioned bone plates seen in the matrix. One such plate goes forward, parallel to the skull roof, from the upper rim of the septum fragment and anteriorly joins a similar, lower plate. The two enclose a much subdivided sinus region which tapers anteriorly and is about 180 mm. long (S. 2 — the compartment whose posterior division Osborn labelled "Ethmoidal sinus (lateral)"). The present specimen does not disclose how far the giant occipito-parieto-frontal sinuses extended forward over the nasal cavity. Another specimen, the *Dolichorhinus* muzzle fragment AMNH 1843, contains a cross break at the front end of the orbits. This plane was not reached by the sinuses: there is no other cavity than the nasal chamber. The two surfaces of the longitudinal section of the *D. hyognathus* skull show a definite border between nasal and paranasal cavities only in one small area — viz., where ethmoturbinates and basis of median sinus septum, attached to the roof of the brain chamber, are preserved in situ.

Many questions arise during the study of this parmedian section of a skull whose interior structures are so largely destroyed. They are mostly answered, as far as they concern the brain region of the cranium, by a transverse section Osborn had made of a smaller specimen, a *Dolichorhinus* skull about 445 mm. long. The anterior portion of the cross-sectioned skull is shown in posterior view in Osborn's fig. 254 D, with the note that the cut was made "near line A-A" of the figure we have reproduced in our fig. 15.

The posterior surface of the transverse section (our fig. 17) shows the same structures as the anterior surface. It is approximately parallel to and 70 mm. in front of the occipital planum nuchale. In the brain chamber some of the matrix is removed on the left side, and the osseous tentorium cerebelli is revealed (t.) Its upper rim is 12 mm. posterior to the section plane. The section, consequently, crosses a posterior region of the cerebral chamber. The cranial bones are very thick around the chamber, particularly above it. Three paired areas containing matrix interrupt the cancellate structure. These are:

1. The paramedian pair of fronto-occipital sinuses whose dorsal part was seen in the longitudinally sectioned specimen. These cavities (S. 1) are extremely high; they reach from the tabula externa down into the groove between the cerebral chambers. As in the longitudinal sec-

tion, they appear to be paired only in the lower part. Here, there is a median septum consisting of right and left plates with some cancellate bone between them. Its ostensible upper end, however, is splintered; further, in the longitudinally sectioned skull, fragments of the median septum are preserved at levels above that where the present septum breaks off; lastly, the roof of the sinus contains a median groove, 1 mm. broad, from whose right side there points down toward the septum a tiny fragment of a perpendicular plate. This appears to have been the upper end of the left plate of the septum. Considering this evidence in the light of the completeness of median septa in other mammals, one is inclined to assume that also in *Dolichorhinus* inner and outer plates of the parietal were medially connected, forming a very high and delicate median septum ("mesethmoid septum" of Osborn's figure) which was broken by the intruding matrix in both the sectioned specimens.

2. A lateral pair of cavities in mid-height of the cranial roof (fig. 17, S2). Osborn labelled these "lateral ethmoid sinus". In Osborn's cross section of the *Palaeosyops* skull, which is in a plane much farther forward, this name was given to the nasoturbinate cavity. The space so labelled by Osborn in the longitudinally sectioned *Dolichorhinus* skull (fig. 15), however, is certainly a sinus compartment, and presumably it does correspond to the left one in the present specimen. There is no reason to call this sinus "lateral"; in the longitudinal section it is seen next to the plane of the median septum (fig. 16, S2). On the assumption that the sinuses were similar in the two sectioned *Dolichorhinus* heads one can infer from the transverse section that the compartments in question diverged posteriorly. They are seen as posteriorly directed pockets in the transversely sectioned skull. Also, one cannot see why these long chambers should be labelled "ethmoidal"; in the transverse section they are pockets, in the parietal bone, of the very large frontal sinus.

3. The mid-height region of the cranium has a peculiar structure. The section reveals here (fig. 17, X) large lateral areas which are neither filled with the coarse matrix found in the brain chamber which they overlie, nor are they filled with fine matrix as exclusively as the pneumatic areas above and median to them. From the latter they further differ in that they are not encased in small-celled bone but extend laterad to the external plate of compact bone. Within these areas, Osborn notes "the remains of the ethmoturbinal scrolls". There are indeed here, scattered through the matrix, bone particles of various shapes, and one or the other does remind one of delicate turbinate lamellae. Further, the area in question is in open connection with the paramedian sinus — as nasal cavities are with paranasal

rim of the septum, but the posterior and upper borders are splintered. Presumably this plate was originally continuous with the similar, somewhat smaller plate lying 7 mm. above it (fig. 16, se.) The latter plate is clearly seen to have continued farther back before the skull was sectioned; it is posteriorly adjoined by an area of matrix bearing the imprint of perpendicular bone (fig. 16, se). This impression shows turbinates under the cerebral chamber (*Elephas, Glyptodon*), and a small-scale process of this kind occurs above the ethmoidal chamber in Carnivora; but a similar process involving such large supra-cerebral spaces does not seem to have been observed in any mammal. *Dolichorhinus* certainly was peculiar also in having upward-radiating turbinals, and a supra-cerebral sinus far larger than the brain cavity. Possibly a study by the serial section method will show that in *Dolichorhinus* the olfactory organ did extend posterad over the braincase to this extreme degree. However, the evidence at hand is not convincing. Besides cut laminae of bone, the section contains bony circles, ovals, and multangulars with indented sides: bone capsules enclosing matrix. There is a gradual increase of bone and decrease of matrix in dorsoventral direction; at the base of the area in question, its structure is the same as that of the ventrally adjoining bone, and I believe that the area was one of loose-meshed diploë.

The two skull sections we have discussed can not reveal the anterior extent of the fronto-parieto-occipital sinus of *Dolichorhinus*. Nothing is known as yet about the interior structure of the orbit region. Horns were not developed. Osborn listed "relatively prominent supraorbital horn swellings on nasals" among the generic characters (p. 396), and "horn cores very prominent" as a specific character of *D. hyognathus* (p. 409). However, the type of this species is a lower jaw, and the only skull Osborn figures is the sectioned specimen AMNH 1851. On this I could not detect horn cores; nor did Osborn have them indicated in the dorsal views of the specimen fig. 346 B and pl. LIII, fig. C — the side views fig. 349 and pl. LII, fig. A — the front view fig. 348A — or the "cross section" (outline) of the anterior orbital region fig. 255, E1.

In another Upper Eocene titanothere, *Diplacodon progressum*, Mr. Bryan Patterson has recently discovered a pair of anteriorly situated lateral sinuses. These are particularly interesting in the present context as they are, it seems, the anterior sinuses described above in *Palaeosyops*, greatly enlarged — in connection with horn formation. According to the sketches Mr. Patterson sent me, this *Diplacodon* sinus extends between nasal chamber and lateral skull wall. It begins at about the middle of the temporal fossa and extends forward beyond the orbit, at least dorsally. It is widest at the postorbital process (as

in *Palaeosyops*). Backward from there, it consists in a slender and tapering diverticle. Over the orbit it is broad. Anteriorly, it tapers at the infraorbital foramen, beyond which reaches a short tapering diverticle. This is (writes Mr. Patterson) "A large, thin-walled, chambered sinus extending beneath and in front of the horn". For, in contrast to *Dolichorhinus*, *Diplacodon* belongs to the family which, "including upper Eocene forerunners of the Oligocene genera *Menodus*, *Brontotherium*", is characterized by "precocious development of horns" (Osborn 1929, p. 434).

To summarize: In the late Eocene, *Dolichorhinus*, with skulls externally similar to *Equus* skulls, had the upper half of the cranium pneumatized, at least medially, back to the occipital bone. By far the largest area of the skull's interior is taken up by the olfactory organ. In *Diplacodon* the antero-lateral sinus, which was small in the Middle Eocene form studied, was greatly expanded in correlation with the development of horns.

The type of cranial pneumatization developed in *Dolichorhinus*, viz., frontal sinuses extending to the occiput, is an exceptional occurrence. Where such high and pneumatic spaces above the brain chamber exist in Recent mammals, they appeared to be an advantageous development in connection with frontal bone horns (ox, giraffe), with a proboscis (elephant, pig), or the giant size of a horn-bearing head (rhinoceros) — that is, the phenomenon was explained by features none of which were present in *Dolichorhinus*. In this ancient titanothere, the discrepancy between skull roof and brain chamber must be due to the fact that, in the Eocene even less than in later times, brain expansion did not keep in step with the development of large skulls. At first thought one has a ready explanation of the extreme pneumatization in *Dolichorhinus*; wide spaces in the large cranium had no function and were therefore invaded by air sinuses. However, similar conditions had not had the same effect in the Middle Eocene titanothere described above, and the enormous crania of Oligocene titanotheres, too, were far less pneumatized than those of *Dolichorhinus*.

IV. The early Oligocene American end-branch of the titanotheres is represented by forms much larger than existed in the Eocene. Height to top of scapula was 1010 mm. in a *Palaeosyops leidyi* and 1030 mm. in a *Dolichorhinus hyognathus*; this height is 1900 in one, 2502 mm. in another mounted skeleton of the Oligocene *Brontops robustus* (Osborn 1929, p. 585) whose skull lengths range from 743 to 843 mm. (ibid., p. 480). In the Oligocene titanotheres a pair of nasal horns projected upward and laterad and/or forward from the skull. These

horns vary from low bosses or short cones to structures of fantastic size and shape. Their cross sections are flat or wide ovals, triangles, circles. They stood over the eyes, on the front tip of the skull, or in an intermediate position. As the other characters on which the genera and the species were based have also been found to be so variable, Scott advised uniting in a single genus all the White River titanotheres (with one exception; 1941, p. 907). They are not descended from the Upper Eocene genus *Dolichorhinus* whose cranial pneumatization we have discussed, nor is *Palaeosyops* regarded as an ancestor of the Oligocene forms. However, they have evolved from early Middle Eocene members of the subfamily Palaeosyopinae (Simpson 1945, p. 255). We can, therefore, take the liberty of regarding as broadly ancestral the conditions found in *Palaeosyops*, viz., paramedian sinuses across anterior cerebral and posterior nasal regions plus small dorsolateral sinuses at the posterior end of the orbit. The latter sinuses we know to have enlarged in the horned Upper Eocene *Diplacodon*, a form in or very near the ancestral line of the Oligocene titanotheres.

I studied horns in the AMNH, YPM and MCZ, and the skull proper mainly in two specimens of the MCZ collection of titanotheres from the Lower Oligocene White River beds of the Dakota-Nebraska-Wyoming region. Both are flat-topped skulls. (Many individuals had the occiput curiously drawn upward; the interior build of that superstructure remains among the several items still not studied.) MCZ 6729, labelled *Menodus proutii*, consists of numerous fragments among which are cranium (brittle), coalesced nasals, and one horn. MCZ 6226, labelled Titanotherium (a name now invalid), consists of large chunks making up most of a very large skull. The middle part is missing, also much of the nasals so that the relative position of the horn — the voluminous base of the left one is in situ — is obscure; an attempt to find a genus name seemed futile. This skull suffered distortion whose result is interesting in the present context. Skull roof and skull base have not been very much put out of shape. It was in the less solid mid-height region of the skull where diagenetic pressure took effect. The ventral regions are now considerably to the right of the formerly corresponding dorsal regions. The cross sections Mr. Stanley J. Olsen made of this distorted skull, therefore, do not represent exactly transverse planes.

Fig. 18 shows the structure of the occipital region. The section plane contains ventrally the anterior end of the left condyle, and dorsally it is 70 mm. anterior to the upper rim of the planum nuchale. This distance happens to be the same as that of the *Dolichorhinus* cross section but in the larger skull the plane is, of course, one relatively farther back. In the figured, posterior surface of the cut the

brain chamber contained the medulla oblongata plus the lower posterior end of the cerebellum. Here, a brain region about 60 mm. high was encapsuled in a cranium about 210 mm. high. The thickness of the roof is medially as much as 105 mm. In the anterior surface of this cut — that is, in a plane 3–4 mm. in front of the figured one — the cranial roof is 90 mm. thick medially, laterally much less. Here is sectioned the wider chamber of the cerebellum, whose configuration explains the puzzling left dorsad and laterad evaginations of the brain chamber, and a separate patch of matrix, in the figured surface. They correspond to posterior lobulations of the left cerebellar hemisphere. The matrix-filled pocket seen descending from the left lower side of the oblongata cast continues in the anterior surface of the cut as a downward canal; it is the hypoglossal "foramen": a canal of considerable length in this bulky skull. In neither posterior nor anterior surface is there a trace of pneumatization of the vast expanse of bone surrounding the brain chamber. The area which in the photo shows darker than the external compacta is penetrated by matrix; it consists of tiny-celled diploë.

Fig. 19, shows this cranium sectioned 130 mm. farther anteriorly. Outside the cranium, the section passes along the anterior edge of the transverse part of the zygomatic process of the temporal bone. Within the cranium, an anterior region of the cerebral chamber is sectioned; the basal groove lodged the olfactory tracts, known to be a particularly prominent feature on titanothere endocranial casts. In contrast to the brain region of the more posterior section, the cerebrum occupied the whole breadth of the cranium. This is also the case in the *Menodus* specimen, in this anterior region as well as farther back where the cerebrum is broader. On the other hand in *Brontotherium ingens* YPM 14169 the cerebral chamber has thick lateral walls in the anterior region disclosed by a transverse section about 28 mm. behind the olfactory bulbs (in the endocast of this cranium the cerebrum is 108 mm. long). In none of the three specimens does the cerebrum extend through the whole height of the cranium. In our section, the cerebral chamber has a roof as high again as the chamber itself. It is not from this bulky bone that there stem the bone fragments seen scattered all through the chamber; they are splinters of the thinner, crushed side walls. The roof is massive as far laterad as to a point beyond the maximum height of each hemisphere. The frontal sinus extended back to the plane of this section, but only dorso-laterally, above the lateral slopes of the cerebrum. Directly over the lateral margin of the cast of each cerebral hemisphere there is a small area within the roof (fig. 19, S?), conspicuous because symmetrical, in which the bone is splintered. The left one contains some matrix. These areas are possible ends of

paired frontal sinus diverticles. The left lateral border of the cranium contains a matrix-filled posterad sinus pocket (S.). This pocket is present, in the same location, both in our *Menodus* specimen and the *Brontotherium* YPM 14169; it represents the most posterior region of the frontal sinus.

The irregular breaks in the *Menodus* cranium allow one to follow the sinus farther forward. The olfactory bulbs were in a rather low position. A transverse break crosses their chambers in about the middle of their lengths. (Remembering the supposed ethmoturbinal scrolls of *Dolichorhinus* in a plane far posterior to the present one, we must mention that turbinates were not found here but begin farther forward in *Menodus*.) Maximum height of the bulbus chambers is 20 mm., that of the massive bone below them, 25 mm. Their roof, however, whose height is 30 mm. +, is bony only medially for about 15 mm. of its breadth, and laterally the roof is massive only in its upper two-thirds. In its lower third lie, over the bulbi, a pair of sinuses. Their smooth posterior walls, with posterad grooves here and there, recede obliquely latero-posteriorly. These perpendicular walls apparently continued to end in the most posterior pocket, that which lies lateral to the latero-anterior slope of each cerebral hemisphere. The frontal sinuses also extended downward along the lateral surfaces of the bulbus chambers. While this is only suggested by the conditions in the *Menodus* specimen, *Brontotherium* YPM 14167 shows chambered sinuses to the right and left of the olfactory bulbs. Thus, while over the anterior slope of the cerebrum the sinus is only a dorso-lateral pouch, it is wider and higher in the bulbus region. The configuration is comparable to that seen, among the Equidae, in *Merychippus*. Once again one recalls the comparisons between extant mammals which seemed to warrant the conclusion that within each order the degree of pneumatization is correlated with body and skull size. However, the two extinct perissodactyl forms with, it seems, similar pneumatization, were very different in size. Shoulder height in *Merychippus* averaged one-half, skull length one-third of that of the American Oligocene titanotheres. Also comparable to the cranial frontal sinus of these titanotheres is that of a similar-sized, recent form from another order, *Hippopotamus*; in the hippo, however, the surrounding diploë is not a tiny-celled honeycomb but a very loose meshwork, and there is another, a large anterior sinus which up to now has not been found in the Oligocene titanotheres.

The region anteriorly adjoining the bulbus chambers is in the two MCZ specimens partly lost, partly in fragments. There seems to have been a solid roof over the nasal chamber, but laterally there were apparently longitudinal pneumatic spaces such as Cope saw in "Sym-

borodon". *Brontotherium* YPM 14169 shows that cavity in a plane about 220 mm. from the planum occipitale, i.e., about 45 mm. anterior to the cribiform plate. In the lateral walls of the ethmoidal labyrinth there is a small tunnel dorsally and a larger one in midheight. These are presumably anterior continuations of the cranial sinus. There is no dorsal compartment such as Osborn figures in *Palaeosyops* between the lateral ones (our fig. 13).

Still farther forward, where the lateral sinuses were broadest in *Palaeosyops*, those of the MCZ titanotherium are, it seems, narrow canals — namely, at the junction of the long temporal fossa with the orbit; this is where a third section was made across our titanotherium specimen.

Fig. 20 shows the anterior surface of this section, viz., a plane crossing the palate 280 mm. posterior to the tip of the premaxillaries. The configuration is not easily understood. In part this is due to the distortion and consequent breakage inside the skull. Besides, however, a region is represented whose topography in the titanothere is not comparable to any one skull region of well-studied Recent ungulates such as the horse (whereas conditions in the tapir, not studied, presumably are comparable). The plane of our section is so far anteriorly that behind it were about two-thirds of the skull. Its unfamiliar appearance is connected with a trend in titanothere evolution just the opposite of one observed in the Equidae. The orbits of the early titanotheres were, like those of the early Equidae, in the middle of the anteroposterior extent of the skull, above the posterior molars. In the Equidae the evolutionary elongation of the muzzle has not involved the orbit; their eyes remained close to the braincase and lie today posterior to the tooth series. In the titanotheres, on the other hand, the orbit shifted anterad (Osborn 1929, fig. 740); in our sectioned specimen the eye lay over the first molar and partly over the second.

We have cut between anterior surface of the $M^3$ and posterior surface of the $M^2$ crowns. This plane is in *Equus* well anterior to the orbit, in the titanothere behind the orbit. Horse heads have been transversely sectioned in an ostensibly corresponding plane, passing between $M^2$ and $M^3$, by Baum (1894, fig. 5), and slightly farther anteriorly, across the posterior part of $M^2$, by Sisson (1940, fig. 455). Those sections cross, besides the nasal passages, the large maxillary sinus and its extension into the ventral turbinate, the frontal sinus extension into the dorsal turbinate, the naso-lacrimal and other canals — including the infraorbital which in the titanothere begins 120 mm. anterior to our section.

Our cut crosses the postorbital process near its posterior surface. In the titanothere this process is a hardly noticeable laterad stump next to the anterior end of the frontal bone, but in *Equus* it is a large structure bracing

cranium and zygomatic arch. Baum's section near the posterior surface of the postorbital process in *Equus* (1894, fig. 7 — a plane far posterior to that of his fig. 5!) is partly reproduced in our fig. 3C. The horse skull here contains the wide frontal sinus of the anterior cranium, the olfactory bulbs, and the last turbinate scrolls above the pharynx. The titanothere section also crosses the junction of temporal fossa and orbit, but it is in the mouth region. The cavities within the skull must all have belonged to the nasal system. Our problem is to decide to what extent they were paranasal, that is, sinuses.

Incidentally we have to mention, as another example of the massiveness of late titanothere bones, that there is not a trace of a maxillary sinus here, in the plane where $M^3$ and $M^2$ adjoin. The large antero-lateral root of the enormous $M^3$ is implanted in massive bone — so deeply implanted that directly above it, where horses have the maxillary sinus, there is in the titanothere the temporal fossa. However, in a maxillary bone fragment which lay over the posterior parts of the $M^3$, there is medially some matrix. Thus there seems to have been a maxillary sinus in our specimen which ended posterior to the plane in which our section crosses the maxillary bone — viz., over the postero-medial root of the last molar. In any case, Mr. Patterson has discovered and will describe just such a sinus in another gigantic Lower Oligocene American titanothere, *Teleodus*.

The lower region of the sectioned fragment ends medially with the palate of the left side; but due to the distortion of the skull the section includes dorsally, above a vast matrix-filled cavity, not only the left nasal bone, but also part of the right one. Thus the midline of the coössified nasal bones can be identified, and it is seen that four pairs of grooves channel their lower surface. The ridges which separate these grooves all end ventrally with broken surfaces. Fragments of bone, narrow in the section, are scattered through the matrix — remnants of laminae which originally continued the ridges. This is particularly clear in the case of the largest of these fragments, whose broken upper end still lies close to the broken median ridge. It is the upper part of the septum nasi which, in life median and perpendicular, went down to the midline of the palate where it stood between the two ventral meati of the nasal channel. The floor of the left ventral meatus is preserved in the specimen, as it is the dorsal surface of the palate. Next to it lie three delicate fragments of the roof, remnants of the left ventral turbinate.

The ridges on the ventral side of the nasal bone are all triangular in section, with rounded sides. This is, I believe, significant — the characteristic attachment of turbinates in contrast to that of sinus septa. Practically all the plates I have seen projecting into sinuses do not have rounded but angular attachments to the main bone tabulae. Such angles are highly variable, whereas the ridges in question are regular. Further, the septa within a sinus pair are rarely, if ever, sym-

metrical. It follows that the large cavity seen in our section is nasal, at least as far as it was roofed by the three more medial pairs of the four symmetrical grooves. These three roofed nasal channels: next to the midline the dorsal meatus (fig. 20 : 1), lateral from this the cavity of the dorsal turbinate (2), and the third the cavity in the ventral turbinate — if conditions in the broad titanothere muzzle were indeed similar to those in the high muzzle of the horse. Horses have between dorsal and ventral turbinate a narrow middle nasal meatus; this may well have been wide in the titanothere.

Identification of the fourth groove must be left to the proposed study of a whole skull in serial sections. This lateral pocket (4) may represent another turbinate cavity but even so, if it was closed anteriorly, it may have been functionally a sinus as are the posterior part of the dorsal turbinate and the ventral part of the ventral turbinate in *Equus*. There may also have been here a genuine sinus compartment. Perhaps the quadrangular piece of bone, which now lies horizontally below the ridge limiting cavity 4, was originally connected with the ridge. However, this appears improbable because that fragment is far thicker than the ridge.

The fragment in question is a part of a weirdly branched and broken thick plate which crosses our section between nasal cavity and temporal fossa. Of course this plate must be, or include, the wall of the temporal fossa; but it was crushed down, and at least its lateral part appears to have been telescoped during the distortion of the skull. Its various processes cannot be identified on the evidence of this one section. They were not necessarily directed in life upward and downward as they are now oriented; for the "plate" may be twisted, or it may have been rotated as a whole at the break seen above the hollow labelled "6".

This hollow opens ventrally towards the temporal fossa; but any reader intrigued by the details of fig. 20, and disappointed with my diffidence in explaining every one of them, will please consider that cavity "6" in the section presumably represents a closed canal, and that such a canal might have contained any one or several of nerves II, III, IV, $V^1$, VI and/or blood vessels, or even the naso-lacrimal duct. In horses this duct leads anteriorly from the orbit into the nasal cavity, whereas our section is at the posterior end of the orbit; but the horses' tears are discharged behind the tooth battery, whereas our section is across the tooth region of the titanothere.

A lateral prong may have been the proximal wall of a cavity (5), and such a cavity would have been a postorbital sinus. One definitely pneumatic cavity is revealed in our section (fig. 20 : S.). Its lower wall is lost; a bone fragment lying nearby in the temporal fossa matrix,

triangular but with one concave side, may have been part of the floor. This sinus is lateral, small, smooth-walled. It is separated from the large and complex cavity described above by a thick sheet of perpendicular bone. The sinus endocast consists of fine-grained stone and thus is strikingly different from the coarse matrix in both nasal cavity and temporal fossa. Thus our titanotherium had a small sinus at the postorbital process. Its latero-dorsal position and its shape are so much like those of the pneumatic canals observed more posteriorly that continuity is strongly suggested. In another skull, YPM 14168, a sinus is seen in the posterior part of the orbit roof, pointing backward towards the postorbital process.

From the specimens I have seen I had the impression that the long, narrow, latero-dorsal pneumatic space has its anterior end in the posterior orbit region — perhaps at the anterior end of the frontal bone. However, my impression is deduced from material which, it must be said again, could not furnish a complete picture of pneumatization in the Oligocene group of titanotheres. Further, variation was great. Sinus configuration must have been particularly variable in the skull region anterior to our third titanotherium-section. In those individuals which had supra-orbital horns, the horn sinus mentioned by Marsh must have been confluent with the sinus just described; thus, the entire orbit roof must have been pneumatic. But other individuals had the horns more anteriorly; in some, the horns were terminal in position, standing on the very tip of the nasal bones (fig. 25) so that the usual anterad nasal shelf (fig. 23) had disappeared. In no one of the specimens available to me for study are all three elements — orbit, nasal shelf and horn — present and broken appropriately for sinus study. The *Menodus* MCZ 6729 fragments include the nasal shelf and one horn; however, the two pieces do not fit together. Therefore the following description of nasals and horns treats separately what surely were two pockets of one sinus — two pockets which, it will be seen, were reduced to one when the nasal shelf was "swallowed" by the horns.

The nasal shelf is solid. Here was a balcony-like structure, a free projection in advance of the horns, overhanging the nasal orifice. It is comparable to that of the rhinoceros, but is broader and stouter. In lateral view, dorsal view (fig. 23) and cross section (fig. 24) it is practically square. The nasal shelf of the rhinoceros tapers to a pointed tip, and it is completely pneumatized — the larger "superstructure" of titanotheres consists of bone throughout, like the corresponding, but very slender structure of the horse. The state of nasal bone fragments in our collections graphically attests to this fact. The shelf broke off as a whole. Such fragments end posteriorly at or just behind

the anterior limit of nasal bone pneumatization; their posterior surfaces reveal a more or less shallow anterad pocket in each nasal bone.

For example, the nasal shelf fragment of "Titanotherium" AMNH 32510 ends posteriorly in an irregular transverse break whose maximum distance from the anterior tips of the nasal bones is 160 mm. In this plane much of each nasal is pneumatized. In the cross break, each nasal contains a roundish sinus which is separated from its opposite by an hourglass-shaped column of bone. This, the median "septum", is narrowed in mid-height to only 11 mm. About 50 mm. farther anteriorly in this specimen the sinuses end. Between the end pockets there is bone with a minimum width of 36 mm. In that transverse plane, total breadth of the shelf is 145 mm. At the anterior margin this thick, solid, 110 mm.-long plate has hardly narrowed; it is 125 mm. broad.

The nasal shelf fragment of *Menodus proutii* MCZ 6729 clearly shows that it was just this squarish projection of the nasals which was solid, and that the sinus end pockets lie where the nasal bones broaden to carry the horns. This fragment is 110 mm. long. Back from the rounded tips, these coalesced nasal bones have parallel lateral borders for about 75 mm. of their length and are 130 mm. broad. Behind this shelf portion the borders diverge (towards the anterior margin of the horns), and the fragment is 170 mm. broad at its posterior end (fig. 24). A broad median region of the fused nasals consists of bone. To its right and left are shallow pneumatic pockets which continued latero-posteriorly beyond the borders of the fragment. These pockets were the anterior ends of a sinus pair whose posterior end we do not know. It is possible that there was only one pair of latero-dorsal cavities, continuous from the anterior cranial region to the front of the muzzle. More probably, there was here a separate paranasal development as peculiar to the titanotheres as are their horns.

The transverse plane in which the solid part of the nasal bones ends posteriorly is that where the horn region begins. As said above, I have not actually seen the sinus in the body of the nasal in connection with that in the hornbase. However, the horn of *Menodus* MCZ 6729, broken from the nasals just described, is pocketed all across its base. There is no indication of even a partial septum setting off this distal pocket from the proximal one. The hornbase sinus appears to have been an upward-laterad outpocketing of the sinus in the adjoining region of the skull proper, i.e. that in the horizontal part of the nasal bone. The pocket in the horn, while wide, is usually shallow. The present *Menodus* horn, for example, is of the bulbous kind, but its sinus did not reach up to the level where it increases in circumference; of its 225 mm. length, only 40 mm. is pneumatized. Naturally, there

was great variability. In our sectioned horn specimen (fig. 21), whose base may not be completely preserved, one-fourth of the length is pneumatized.

It follows that the heaviness of titanothere horns is only to some extent due to the fact that we handle them in a fossilized state. They must also have been extremely heavy when carried on the living heads. Like the nasal shelves, these horns were largely solid. The horn MCZ 11698, which we have sectioned (fig. 21), is of the sub-conical, round-based type which rose behind a nasal shelf. It is filled with small-celled spongiosa. The streaks of dense bone seen in the section must have been either columns or walls of compacta within the diploïc mass. Smooth compacta walls off the basal sinus—evenly vaulted in this specimen; in other horns such sinus pockets are partly subdivided by one or more irregular, low ridges (fig. 22).

It is odd that practically no notice has been taken of these hornbase sinuses, for they are quite conspicuous features in the majority of isolated horn specimens. In the collections I have visited are some titanothere horns broken by chance at various levels; naturally, this mass of cancellate bone with its thin coat of compacta is as likely to break at one level as at another. However, most horns are broken from the skulls in a manner obviously correlated with their particular kind of pneumatization. In significant contrast to the condition in which paleontologists find the horns of broken cavicornian skulls, a titanothere horn specimen is usually a horn from tip to base — the whole horn, and nothing but the horn. It is usually broken from the remainder of the nasal bone in the only plane in which it consists of relatively thin bone, namely, where its sinus is widest: at the junction of horn and skull proper. The sinus is a conspicuous feature in such fragments because its wall is the only finished area of the whole surface. Further, while in relation to the horn the basal pocket is small, like everything in those giants it is absolutely large. At the proximal end of the *Menodus* horn MCZ 6729, the maximum diameters of the horn base sinus are 140 and 75 mm. Only at their roots were the horns really hollow. Regardless of the horn's form, the sinus rapidly tapers distally in the majority of cases.

As said above, it was Marsh who discovered these hornbase sinuses, and he called them "large" (1876 b, p. 335). Indeed Marsh's YPM collection contains three horns in which the sinus reaches unusually far up. While two of them represent extreme variation towards large size of the horn sinus in adults, the extent of the sinus in the third specimen is possibly related to young age of the individual. One horn of YPM 14170 is broken lengthwise, revealing the endocast of a sinus rising through the proximal half. Another large horn, YPM 14171,

with a 100 mm.-diameter at the base, is preserved as an 85 mm.-high stump; at the level of the break this horn contains a central cavity 42 mm. wide (strangely, not seeming to be connected with that in the hornbase). YPM 14168 is a small skull in fragments. The more complete one of its conical horns is only 120 mm. long; through half its length goes a wide, partially subdivided sinus pocket. This young horn is an interesting illustration of differences between horns developed in the early Oligocene and the cavicornian horns of later times. In the ontogeny of Cavicornia the sinus expands at a greater rate than the horn core grows, so that older horns are more hollow than young ones. One is not judging from only the one young titanothere horn when one believes that in that group there was very little sinus expansion while the horn was built up to enormous size; this is also clear from the condition of the adult horns. We have quoted above (p. 454) Andrews' description of *Arsinoitherium* horns; it suggests that in these horns, too — but on a smaller scale than in the present case — the solid bone portion increased during ontogeny instead of becoming thinner as it does, at least relatively, in Cavicornia.

Following Osborn's reasonable assumption that the titanotheres with terminal horns have evolved from forms with lateral horns, we find reduction of pneumatization also in phyletic evolution.

*Brontotherium platyceras* (fig. 25) was the largest among the American Oligocene forms (a skull is 880 mm. long). It "represents the climax of the evolution of the long-horned titanotheres" (Osborn 1929, p. 579). Its nasal bone sinus, however, is not larger than in the forms from which it has developed. Naturally, the nasal sinus of *B. platyceras* extends farther forward to reach the anteriorly placed horn-bases; but it has lost the pockets which in the forms described above pneumatize the hornbases.

*B. platyceras* MCZ 9160 consists of the horns and the horizontal plate of the nasals, which is preserved in a (maximum, median) length of 190 mm. The irregular transverse break at the back end of this specimen slopes antero-ventrally. In this section are seen a pair of sinuses. They are wider than in the more posterior plane shown in fig. 20, but even so they do not make the nasal bones hollow as is the case in rhinos; they lie to the right and left of the choana roof. On the level of the greatest width of these sinuses, the coalesced nasal bones are 180 mm. broad, the left sinus 32 mm., the right one 39 mm. Both are oval in the oblique section which the break has produced. A line continuing the axis of each horn downward through the skull roof would be the long axis of the sinus oval. But there was no outpocketing towards the horns of these dorso-lateral longitudinal pneumatic channels — neither in this transverse plane where the horns had

stood in ancestral species, nor farther anteriorly where rise the gigantic horns of this form. In the *Brontotherium platyceras* nasals we find not two pairs of tabula interna vaults but only one pair — the anterad pockets in the center of the body of each nasal bone (fig. 22). This has "swallowed" the horn-base sinus. In this species, "The connecting crest between the horns has grown to such a height and the horns to such a breadth that in front view the head terminates in a great vertical plate 6.75 inches deep and more than 18 inches broad at its widest part" (169 mm. and 450 mm., respectively; Obsorn 1929, p. 579). It is not possible to draw, across this plate, lines exactly separating the horns from the connecting crest (which consists of the anterior ends of nasal bones not projecting in advance of the horns). However, it is clearly seen that the pneumatic pockets are in the middle part of the crest-horns-complex. Characteristically, the right and left pockets are quite different. A ridge divides the left one into two pockets, one of which has two narrow anterad diverticles; the end-pocket of the right sinus is one smooth anterad vault next to the anterior end of the nasal bone. The horns of *B. platyceras* are, consequently, solid throughout.

The *Brontotherium* fragment whose posterior surface is here described and figured (fig. 22) is the type of *Menodus platyceras* Scott & Osborn 1887. With the original description (p. 160–163) this specimen, MCZ 11214, is figured (fig. 4) in anterior and in lateral views, with an outline (called "section") of a horn in dorsal view. Osborn's monograph (1929) repeatedly refers to this specimen. The original description ("Scott and Osborn write") is quoted p. 221–222 with fig. 178. The diagrammatic "section at base of horn" is seen in figs. 375G, 399, 458 and 481A, and the latter figure also contains the outline of a horn in medial view. The general description of the species, now called *Brontotherium platyceras*, mentions "the type horns in the Harvard museum" p. 579. Their estimated external length is given as **400** *mm.* on p. 553. Since Osborn described (p. 221) as the inner contour of the horns the posterior one, "Outside length of horns, **315** *mm.*," (p. 222) should be the anterior length and thus identical with "Length of horns measured from tips to median fronto-nasal suture, **250** *mm.*" (p. 161 in the 1887 paper, from which the 1929 passage purports to be quoted). The opportunity is taken here to point out that in the type specimen 315 is the correct measurement and that, further, it is length of horn plus one-half "crest".

Looking back over this first and very incomplete survey of pneumatization in titanotheres, one can venture the following tentative outline of origin and evolution of frontal sinuses in this diversified group. The titanotheres evolved from the same perissodactyl root as the Equidae with, consequently, un-pneumatized skulls. The earliest genus of whose pneumatization we know is the Middle Eocene *Palae-*

*osyops*. This form was already large-skulled and still small-brained, as were the later titanotheres. Two paired sinuses were found in the frontal bone. One lies across and in front of the anterior slope of the cerebrum, the other over and behind the posterior end of the orbit. In the phylum which did not develop super-structures on the skull, excessive pneumatization hollowed the upper half of the cranium in the Upper Eocene *Dolichorhinus*. In the phylum which developed giant animals with gigantic horns, the greater part of the vast cranial roof was massive in the Lower Oligocene end-forms. The frontal sinus had its main area, as in *Equus*, around the olfactory bulb chambers. Tapering pockets, smaller than the supra-cerebral sinus of *Palaeosyops*, extended back to the latero-anterior slope of the cerebral chamber. Anteriorly, the sinus narrows to a dorsal channel inside the lateral margin of the frontal bone. It either ended in the posterior part of the orbital region or was continuous with a similar sinus in the nasal bone. In forms with lateral horns, the nasal bone sinus evaginated into the horns; but it failed to pneumatize either the horns or the large nasal bone shelf in front of the horns. In forms with terminal horns, the lateral evaginations have disappeared.

On pl. IX we show the dorsal aspect of an entire *Brontotherium platyceras* skull, the anterior end above, alongside one of *Bos taurus* in opposite orientation. There is a striking similarity of outlines. The brontothere horns enlarge the anterior end of the head much as the ox horns enlarge the posterior end. The solidity of the Oligocene horns graphically illustrates the weakness of overall theories based on so small an assemblage of mammals as are the Recent genera. Anatomists studying Recent mammals are under the impression that air sinuses actively develop whenever a heavy skull, wherever a superstructure needs to be lightened. Should not horns on the very tip of the roof of the necessarily hollow nasal chamber have more need of being pneumatized than horns broadly anchored on the most voluminous region of the skull? Would it not have been "easier" for pneumatization to extend into horns situated in the immediate proximity to the channel through the head which supplies the air for all pneumatization than in the case of horns which stand on the far-away occiput? Actually, it is the latter which are hollow, not the nasal horns of the Oligocene titanotheres.

As long as we know no more about the sinuses of titanotheres than the data assembled in this chapter, two lines of speculation are open regarding the solidity of the Oligocene titanothere skulls.

In the evolutionary history of other mammal groups we have seen that skull pneumatization is a progressive feature. The titanotheres, however, were a group in which, "Although the later members were spectacular animals, the amount of fundamental progress, variety and important novelty . . . was slight" (Simpson 1945, p. 255). With regard to frontal sinuses, the Dolichorhininae did achieve important novelty, but in the brontothere line not even the development of giant size increased the degree of pneumatization.

On the other hand, it appears that the cranial frontal sinus was relatively larger in a Middle Eocene ancestor than in the Lower Oligocene forms, and the sinus under the horn seems to have been more extensive in an Upper Eocene ancestor. The Oligocene condition thus may have to be regarded as secondary—as a result of the trend towards solidity of the entire skeleton in the phylogeny of the titanotheres.

I have not found any specific data on the inner structure of the post-cranial bones in the pre-Oligocene forms, but we know that in the Lower Eocene only were the titanotheres as light-limbed as the Equidae. Already in the Middle Eocene "these animals were heavier bodied and slower moving of limb than the modern tapirs" (Osborn 1929, p. 608). In the Oligocene, the post-cranial bones were solid. According to Scott (1941, p. 874 — on characters of the Oligocene forms), "the skeleton underwent an adjustment to the mechanical needs of supporting great weight, the long bones loosing the marrow-cavities, which became more or less filled with cancellous bone." However, that trend does not appear so advantageous when now we realize that it was not restricted to the long bones. In the skull, the trend towards solidity apparently reversed the tendency observed in the majority of mammalian phyla, viz., expansion of pneumatization during size increase. Except in the nasal area which carried the horns, the gigantic Lower Oligocene skulls were less pneumatized than smaller skulls from the Middle and Upper Eocene.

The fact that a comparable trend towards massiveness is observed in two water-adapted groups is another difficulty in the interpretation as an adaptive feature in titanotheres. Granger and Gregory speak of "the pachyostosis of the horns" of certain late titanotheres (1943, p. 367). But it is the pachyostosis (so called after the disease which in human bones obliterates the marrow cavities) of Mesosauria and Sirenia which has fascinated the paleo-endocrinologists, headed by Nopcsa. Pachyostosis seemed, in evolution, "to begin always in a certain stage of adaptation to aquatic life, and it disappears later on" (Nopcsa 1923, p. 116). In the phylogeny of the Sirenia pachyostosis has continued to increase, but this is easily explained by the iodine in the algae the seacows feed on . . . (ibid., p. 117). Nopcsa and some of those who discussed his ideas at the 1922 meeting of the Paläontologische Gesellschaft (Paläont. Zeitschr. 1923, vol. 5, p. 258–265) found that practically every evolutionary development of phenomena which in man result from diseases benefits the animals concerned. Unfortunately, titanotheres were not included in that discussion.

*Rhinocerotidae.* The largest of living perissodactyls are comparable to the late titanotheres insofar as they are giants and carry one or two horns on the nasals. Their skulls, however, are extensively pneumatized. The frontal sinus of the two-horned *Ceratotherium* (Paulli 1900, figs. 4–5 and pl. VIII) pneumatizes the whole skull roof, from the tip of the nasals to the back of the occiput. According to Weinert (1925, p. 266), this is the condition in all extant rhinos.

In the case of the Rhinocerotidae fossil evidence shows even more distinctly than the case of the titanotheres that, contrary to current

opinion, the development of horns was not decisive in the development of pneumatization. The huge paranasal sinuses antedated the origin of the horn-bearing osseous protuberance. The influence of the horn on the sinus was limited to the immediate proximity of the horn. The extinct genera follow each other in time, but they are not ancestral to each other or to *Ceratotherium*.

As in the Equidae, frontal sinuses were late to develop. *Hyrachyus princeps* of the late Middle Eocene is the largest species of that genus, a complete skull being 346 mm. long (Wood 1934, p. 281). *Hyrachyus* cf. *princeps* YPM 12529 is a cranial roof which ends anteriorly in breaks of various directions above the ethmoidal chamber; a right side break reveals, further, the interior structure of the frontal bone roof of the anterior cerebral region. The whole space between tabula externa and interna, 20 mm. high at the ethmoidal windows, is filled with spongy bone. "In the ancient Rhinoceroses of America there is no diploë; the osseous cranial wall is solid in the Oligocene Aceratheres and even in the Upper Miocene *A. fossiger*" (Osborn 1898, p. 119). Of another hornless predecessor of the living rhinos, the Mio-Pliocene *Chilotherium* (skull lengths 490–541 mm.), there exists a natural endocast of a whole Upper Miocene skull (Edinger 1937). Here the frontal sinuses are very extensive, similar to those of the Pleistocene and Recent rhinos. As in these forms with steeply rising parietals and a very high occiput, parietal and occipital bones were pneumatized in *Chilotherium*, whose skull roof was almost flat. The nasal bones, however, were horse-like in the hornless Mio-Pliocene form. Thus it seems that in rhinoceroses the nasal bones became pneumatized only when their outer plates bulged upward to provide the horn base. Brandt (1849) has given a striking figure (pl. XVIII) of pneumatization in the Pleistocene *Coelodonta antiquitatis*, and a graphic description (p. 283–284); "the air cells are so large and numerous that almost all the bones of the skull are, by their cellular cavities, connected with the nasal cavity". The nasal is not mentioned among the pneumatic bones which Brandt lists by name, and it is not sectioned in his figured specimen; but he mentions (p. 268, 283) large air cells in the posterior and basal parts of the bone distinctive of the species, the ossification of the nasal septum under the horn.

Even from the scant material described in the literature it is clear that the various branches of the rhinocerotoid evolutionary "bush" acquired pneumatization at different times. Different reasons can perhaps be found. The "Upper Miocene *A. fossiger*" Osborn refers to in the statement quoted above is *Teleoceras*, Upper Miocene or Lower Pliocene in age; but it does not seem to have developed the braincase pneumatization which was found so extensive in its similar-

sized and contemporary cousin, *Chilotherium*. *Teleoceras* probably had a nasal horn; it may have had sinuses in the nasal bones. This may be true also of the Miocene *Diceratherium* which possessed a pair of nasal horns. But all this has not been investigated. With regard to the roles played in the causation of frontal sinuses by horns, by skull size, and by vaulted cerebral hemispheres, it is deplorable that the skull of the Upper Oligocene hornless giant *Baluchitherium* is now a reconstructed exhibition specimen. A longitudinal section was drawn when the skull was under investigation (Granger and Gregory 1936, pl. II), but no details of bone structure are shown. Presumably no details were recognizable in this unique specimen.

Let us realize, here at the end of our survey of frontal sinuses in Tertiary mammals, that the record is poor not alone because interest in pneumatization may have been lacking. Relatively few fossil skulls are — as found, without intentional sectioning — appropriate material for such studies.

## 4. The Equidae

We have digressed from our own story, that of frontal sinus evolution in the Equidae. A survey of pneumatization and its possible causes in other mammals was necessary as a general setting for our one case and as an aid in its interpretation. All other special studies in pneumatization, concerning as they do the extant mammals, are based on specimens more satisfactory than our fossil ones. Our specimens, however, have the advantage of being from consecutive geological periods, and they constitute a phyletic series, including the earliest form recognizable as an equid.

The material studied consists of crania and endocranial casts which had been assembled for brain studies. The immediate impression obtained from this series of specimens was that expansion of the anterior cerebral region — and thus of the braincase — was the major factor in disturbing the original harmony between the surface of the skull and the organs encapsulated within the skull; that, consequently, progressive brain evolution was the main cause of the intra-cranial incongruities in which the frontal sinus developed. However, the survey of frontal bone pneumatization in other mammals showed sinus formation to be influenced by the specialization of this, or another, or several elements of the skull, by skull size, the size and even the general constitution of the body. Inside the skull of the Equidae, expansion of the cerebrum is the evolutionary process which happens to have been studied step by step in a special investigation. The other factors likely to participate in the causing of pneumatization must now be considered.

The gains in body and skull size failed to induce skull roof pneumatization up to the early Miocene. We have seen the interior matter of the frontal bone loosen up in the late Oligocene and early Miocene, preliminary to cavity formation, and size must be presumed to have played a role in this process. However, no sinus was formed in the Lower Miocene *Parahippus* MCZ 17878, a skull far larger than that to which belonged the Middle Miocene *Merychippus* fragment AMNH 32671, the oldest of our specimens which contains a frontal sinus. But size certainly was a factor in the later expanding of the sinus; with the skull's enlargement, discrepancies present must have grown, whatever had been their original cause. Further, the chief evolutionary change in the equid skull was one correlated with the successive increase in body size: the increasing preponderance of the facial skull, i.e. masticatory apparatus + nasal tunnel, over braincase + orbits.

The authors who studied this transformation have studied the changing length proportions. For the detection of disharmonious development in the frontal sinus region more and different measurements would of course be necessary. Presumably it has been regarded as superfluous to study the manner in which facial and cranial heights and breadths have increased; while the skull enlarged, its shape appears to have remained very much the same except for the change in pre/post-orbital length proportion. Still, a necessarily brief comparison of breadth and height differences between *Hyracotherium* and *Equus* may be of interest in the present context, if only to show how great was the expansion of the skull in 55,000,000 years of horse evolution.

The specimens measured are the *Hyracotherium venticolum* type skull (in Cope's pl. 49[a], 1884), and the two *Hyracotherium* fragments and 2½ *Equus* skulls at hand. While skull length changed from 135 to an average of 583 mm (1 : 4.3), neurocranium breadth increased from 28 to 122 mm. (1 : 4.4). In height the neurocranium gained less, from 32 to 113 mm. (1 : 3.5), but the facial skull gained more. At the infraorbital foramen, muzzle height in eohippus AMNH 14810 is 28 mm. (above $P^4$), in the three *Equus* 140 (above $P^4$), 135 (above $M^1$) and 150 (above $M^1$), respectively, so that *Hyracotherium* compares to the *Equus* average as 1 : 5.1. The mean of the posterior and anterior height ratios is 1 : 4.3. This number may be the result of playful juggling with a few figures, or it may be found to be the height increase ratio of the main frontal sinus region which is in a position intermediate between those of the two height measurements taken. The length, breadth and height ratios arrived at in the present rather unreliable manner are certainly amazingly similar. A different kind

of material indicates that an elongated muzzle is not in itself a factor creating or enlarging a frontal sinus; in the hippopotami (fig. 5) it is the shorter-faced type which has the larger sinus.

In fossil and living mammalia the development of skull superstructures is generally correlated with body size. Crests in particular are a feature of large animals which is lacking in smaller related forms, and they are known as a factor in pneumatization. As mentioned above (p. 427) there is nothing comparable in the ancestral series of the Equidae. The trend in equid evolution was the opposite of that generally observed. The small *Hyracotherium* had a rather conspicuous medio-sagittal crest on eight-ninths of the length of the cranium. A lower crest was on five-eighths of the cranium of *Mesohippus* — naturally, with some variation. Definite crests of variable extent and strength occur in *Miohippus, Parahippus,* and in *Merychippus* where I found it one-half the length of the cranial roof. One-half seems the rule also in *Equus;* but in this largest of the Equidae, which has the largest frontal sinus, the original sagittal crest has dwindled to "a more or less prominent line" (Sisson 1940, p. 57). It seems that in *Equus* a crest had become superfluous; the wide and high cranial box alone is large enough to provide a sufficient surface for the attachment of the extensive head muscles.

One external structure enlarged considerably, and changed in shape and in relative position, with the enlargement of the equid skull. The postorbital process of the frontal bone is a mere stump in *Hyracotherium.* It joins the frontal process of the zygomatic bone only in the *Merychippus* stage of horse evolution. The postorbital bar thus formed is slender in some, broader in other *Merychippus* specimens, and since this stage it has increasingly become a more voluminous structure. In *Hyracotherium* the interior of the postorbital process consisted of cancellate bone tissue; the bar in *Equus* is pneumatized. The expansion of the process has considerably added to the frontal bone but outside the cranial circumference. The process was invaded by the sinus; but has it contributed to its origin? (One may note that the extremely pneumatic pig skull has only a postorbital stump.) Knowledge of the internal structure of the postorbital process of *Merychippus* frontal bones might help to decide this question.

The anterior rim of the postorbital process or bar is the posterior border of the orbit. The phylogenetic shift of the anterior orbital border is a much-studied, well-established fact. I found the posterior border of the orbit remarkably conservative in its relation to the structure it adjoins medially, viz., the constriction of the cranium which marks the anterior end of the cerebral capsule. Only in *Hyracotherium* is the postorbital process anterior to the cranial constriction.

Since the *Mesohippus* stage, cranial constriction and postorbital process have occupied the same transverse skull region; in *Equus* the plane of the constriction is generally that of the posterior border of the process. (My remarks 1948, p. 117, on certain topographical changes in this region, refer to the anterior extremity not of the cerebral capsule but of the braincase, the location of the cribriform plate.) The transverse skull region at the anterior end of the cerebrum is that in which, as we have seen, the frontal sinus originated in *Merychippus* and has its greatest diameters in *Equus*. Therefore it is interesting that this region was always broadened dorsally by the postorbital process of the frontal bone, long before the stage in which the nucleus of the frontal sinus developed and the process contacted the zygomatic bone.

The great preorbital changes of the equid skull thus appear to be hardly reflected in the posterior region of the orbit. This suggests that the conspicuous "backward shift" of the orbits was no factor in the causation of the frontal sinus proper. The shift was rather a change in the topography of more anterior skull regions. A survey of published figures shows the anterior border of the orbit above $M^2$ from *Hyracotherium* to *Miohippus;* in *Parahippus* the same or above the anterior end of $M^3$; in *Merychippus* and *Pliohippus* above $M^3$ or its posterior end; in *Equus* the entire dental region is "removed" from the orbital region. This process in horse evolution must have given the maxillary sinus considerable possibility, or cause for enlargement. The lateral, orbital sections of the frontal sinus must also have been involved in the process; but a direct influence of this preorbital reconstruction on the mainly postorbital frontal sinus proper seems highly improbable.

Has the expansion of the olfactory organ, so much greater than that of the brain, produced discrepancies which called for pneumatization? One cannot simply take as an affirmative answer the fact that mammals with reduced olfactory organs have no frontal sinus (Cetacea, etc.) or a small frontal sinus (*Homo*). Not only have macrosmatic lower mammals unpneumatized frontals, too, but in all these forms the skull structure is so utterly different from that of the horses that such comparisons teach nothing about frontal sinus development in the Equidae. In equid evolution ethmoidal labyrinth and braincase actually have extended their contact more than would correspond to their general enlargement. As in living mammals with a primitive type of brain, the nasal capsule adjoined the braincase anteriorly in *Hyracotherium*. It was mainly in front of the brain in the *Mesohippus* stage; only the posterior extremity reached back below the olfactory bulb chambers (fig. 2). With progressive evolution the

cribriform plate comes to face downward as well as forward and, concomitantly, the nasal capsule extends posterad. Thus one finds in *Equus* a pars subcerebralis added to the original, precerebral labyrinth (fig. 3A). Dorsally, however, this same progressive evolution does bring about a discrepancy between braincase and ethmoidal labyrinth: through the relatively low position of the brain part of the olfactory organ, the bulbi. This, we believe to have shown above (and 1948, p. 145–146), is the result of the progressive expansion of the cerebrum.

Has the masticatory apparatus played a decisive role in frontal sinus formation? A remote relation no doubt existed, because the formation of hypsodont teeth, of the frontal sinus, and an anterior vaulting of the cerebrum all are features started during the Middle Miocene reconstruction of the equid skull. They must have been correlated insofar as none of them basically changed the shape of the skull, although they are manifestations of different trends — higher crowned teeth an adaptation, to the hard grasses which first appeared at just this time (Stirton 1947, e.g., p. 36) — cerebral expansion the result of a force largely independent of body evolution — sinuses originating in discrepancies caused by unharmonious evolution of the skull components. Possibly, knowledge of the anterior extent of the frontal sinus in *Merychippus* will aid in distinguishing between the influence on the frontal sinus of the teeth, anteriorly, and the brain, posteriorly. The following conditions in Recent mammals are perhaps significant in this respect. The hypsodont, low-brained rodents generally have no frontal sinus (it is recorded only in the peculiar skull of *Hystrix*, and the large forms *Myopotamus* and *Hydrochoerus* — Paulli 1900, p. 516, 517, 521). The brachyodont *Tapirus* has considerable frontal sinuses in front of its high cerebral capsule (Paulli 1900, fig. 2).

Data on the possible role of hypsodont teeth on the one hand, and the role of the braincase on the other hand in the evolution of the equid frontal sinus, can presumably be found in the Mio-Pliocene "forest horses". In this side-branch of the *Equus* ancestry a progressive feature is the high and rounded braincase, while among the many primitive features are persistently brachyodont teeth. "The development of large frontal sinuses" was recorded by Scott (1895, p. 97) in the type of *Hypohippus equinus;* but this statement was based on an error. The specimen contains only two identifiable fragments of the cranium — one an ear region, the other a part of the left and dorsal cranial wall. The lateral processes at the anterior and posterior ends of the latter fragment are shown in Scott's side view reconstruction of the skull (loc. cit., pl. III, fig.23) enclosing the orbit; they are, however, the zygomatic processes of the temporal and frontal bones (as which they are rightly described loc. cit., p. 97). The cavity which Scott saw on the medial side of this

fragment was, consequently, not a sinus but it belonged to the cerebral chamber. Dr. Jepsen had kindly cleaned of matrix the inside of the specimen before I studied it. Impressions of cerebral gyri are now easily seen and, further, a short stretch of the falx cerebri. *Hypohippus* may have had frontal sinuses, but not in the region preserved in this specimen (Princeton University no. 10404).

Thus discussing each element regarded as influencing frontal sinus formation in other mammals has only turned us back to that element the star role of which had been suggested by the equid material itself. All structures adjoining the sinus must have participated, through different developments and shifts, in shaping the sinus; in fact the "function" of the frontal sinus is to mediate between these structures. In none of these structures, however, have I found changes during equid evolution which could be regarded as decisive in originating the frontal sinus proper, except in the brain (p. 430).

The cerebrum has expanded and changed in form, in the evolution of the Equidae as of vertebrates in general, largely independent of body and skull size. Therefore, if the origin of the equid frontal sinus really was due to the evolutionary expansion of the anterior cerebral region and the concomitant relegation of the olfactory bulbs to a successively lower region of the skull, the origin of the frontal sinus proper is another feature in equid phylogeny not connected with the gradual size increase. Size increase, through the changes in skull size and structure related to it, has thereafter enlarged and shaped the frontal sinus proper as well as the orbital and turbinate pneumatic cavities which in *Equus* are parts of the frontal sinus s.l.

The origin of these latter cavities is a different story. It cannot be told from the material at hand — un-pneumatized orbit roofs of *Mesohippus*, and the endocast of what appears to be a small sinus anterior to the olfactory bulbs and medial to the orbit in *Parahippus* MCZ 17878. In ungulate ontogeny the Anlagen of the anterior sinus portions precede those of the frontal sinus proper; in an artiodactyl phylogeny we have seen supra-orbital sinuses developed before the frontal sinus proper came into existence. Seen historically, it seems probable that the air cavities in the anterior part of the orbit and in front of it were facial formations with a separate origin and with causes different from those which gave rise to the cranial sinus in the frontal bone. If this was the case, they have become secondarily, by confluence, the "anterior frontal sinus regions" as which they appear today in the morphology of the adult horse skull.

## V. SUMMARY

The frontal sinus of *Equus caballus*, frequently described in the literature, was studied with particular regard to the structures it adjoins. The deepest and broadest sinus area overlies the anterior slope of the cerebral chamber and envelops from above and laterally the olfactory bulb chambers. It tapers out over the ethmoidal labyrinth, but except for this anterior region in the nasal it is within the frontal bone, a frontal sinus sensu stricto. The frontal sinus of current nomenclature includes latero-anterior cavities with which the main cavity is continuous; these pneumatize the wall and roof of the orbit and a posterior portion of the dorsal turbinate.

The area corresponding to that of the frontal sinus proper was studied in crania of some fossil Equidae. The sinus did not exist in the early ancestors of the horse. In its place, Lower Eocene to Middle Oligocene skulls have small-celled cancellate bone, Upper Oligocene and Lower Miocene specimens a more extensive layer of coarser spongiosa. The first frontal sinuses were found in a Middle Miocene representative of the genus *Merychippus*. This small phyletic Anlage developed in that section of the skull in which the Recent cavity is widest. The frontal sinus of *Merychippus* lay laterally over the anterior slope of each cerebral hemisphere and olfactory bulb, while the median region of the frontal bone was not yet pneumatized.

From a survey of the various evolutionary changes observed in the equid skull it is concluded that cerebral expansion was the decisive factor in the origin of the frontal sinus. In the *Merychippus* stage the equid cerebrum first developed an anterior facies which rose considerably above the bulbi. This created a major discrepancy between the tabulae externa and interna of the frontal bone, and the unoccupied space was invaded by air. In the evolutionary expansion of the sinus other factors came into play besides increased anterior vaulting of the cerebrum. Enlargement of the head in particular caused and enlarged discrepancies between the elements of the skull, that is, spaces not used and therefore subject to pneumatization.

This story of the equid frontal sinus agrees with Weidenreich's theory of sinus origin and evolution, deduced from extant conditions. Sinuses have no function. They occupy dead spaces which have resulted from disharmonious growth of the skull components, viz., the capsules of brain and sense organs, the tooth apparatus, and the outer plates of the skull.

Also in agreement with this concept is the general impression obtained from a survey of frontal bone pneumatization in the extant mammals. Its infinite variation is baffling; from this fact alone it can

be deduced that there is no one explanation for all the differences. In general it is true that larger skulls are more extensively pneumatized than small ones of comparable build; but not even size differences have in different groups the same correlation with the extent of pneumatization — enlargement of a skull cannot ever have been a congruent enlargement of all the skull elements. In a number of cases one easily sees the relation between size of sinus and arrangement of skull components; a frontal bone horn, for example, has lifted the cranial roof plate from the braincase, and the resulting incongruity between the tabulae externa and interna was pneumatized. Recent heads, however, can rarely reveal the actual origin of the pneumatized discrepancies within the skull. It is obvious that there are many possible causes of origin and expansion of frontal sinuses, and they must have been different in different phylogenies.

Such different causes, and conditions in early Tertiary mammals strikingly different from those in roughly comparable Recent forms, are brought to light in a survey of paleontological data. Most of these findings are chance observations on chance breaks — cavities or sinus endocasts accidentally, and in general only partly revealed. Sectioned fossil skulls have rarely been used for sinus study, and serially sectioned skulls never. In almost no genus have sinuses been noted in more than one specimen — and individual variability is particularly characteristic of sinuses. Very few of the genera studied are phyletically connected. On such data rests the following summary of frontal sinuses in Tertiary mammals. It is brought together from the literature and the author's studies of Eocene and Oligocene specimens.

In toxodonts a frontal sinus was present from the Upper Eocene onwards; the earliest was associated with a peculiar downward bend of the anterior brain region which bent the inner plate of the frontal bone away from the outer plate. An armadillo frontal sinus is reported from as early a time as the Lower Eocene, and from the same strata a domed, pneumatic forehead of an astropothere is known. Quite recently a Paleocene frontal sinus has been discovered; it pneumatized a small part of the enormously thick skull roof, from the anterior brain region forward, in a large pantodont. To judge from the other data known, such early occurrence of frontal sinuses was exceptional.

One genus of Oligocene Canidae lacked the frontal sinus; another developed a short, low cavity; but this was well developed in larger, Miocene and Pliocene forms with a domed connection of cranium and muzzle. A Middle Oligocene artiodactyl, whose orbit roof was pneumatic, had no frontal sinus proper; an Upper Oligocene, larger descendant developed a sagittal crest and below this the supra-cerebral sinus. In Eocene, Oligocene and some Miocene Rhinocerotidae no sinuses

could be found; at least one Upper Miocene hornless genus had the wide pneumatic cavities comparable to those of extant rhinos except that the nasal bones were not involved; clearly it was the development of the horn base through which Pleistocene and Recent forms have added sinus compartments in the nasal bones, to arrive at their extreme pneumatization of the entire skull roof.

This condition in the extant perissodactyl giant contrasts notably with that in the extinct archaic groups of rhino-like habitus and size, the Middle Eocene uintatheres and the Lower Oligocene end-forms of the titanotheres. The bones of their gigantic heads were largely massive. Their enormous bony horns were invaded by diverticula from adjoining sinuses, but these hardly ever reached beyond the horn base. *Uintatherium* appears to have had, besides maxillary sinuses expanding into the bases of the middle horn pair, a pair of narrow air tunnels over the olfactory bulb chambers, extending into the bases of the posterior horns.

Pneumatization in the titanotheres is better documented; we have data not from one but from three stages of the early Tertiary. The Middle Eocene *Palaeosyops* was the size of a very large tapir. It had a frontal sinus proper over the bulbi and anterior cerebrum, plus a lateral sinus at the postorbital process. Nevertheless the skull roof, which was very thick, consisted mainly of bone. The pneumatized areas were far smaller in *Palaeosyops* than they are in tapirs. There is, further, a great difference between the skulls of the Middle Eocene and the Recent perissodactyl with regard to the size of the brain capsule. The large head of *Paleosyops* was developed at a time of mammalian history in which cerebral expansion was in a slow stage and brains of large mammals were, consequently, small. It seems that frontal sinus expansion likewise did not keep step with skull enlargement in the manner known in present-day mammals. In *Palaeosyops*, as in the contemporary *Uintatherium*, and in the Paleocene *Haplolambda*, the vast roof of the small brain chamber contains a sinus only in the lower half of its anterior region.

This condition was still present in the Lower Oligocene descendants of *Palaeosyops*. The brain capsule of these later titanotheres was a huge mass of solid bone. A restricted frontal sinus existed, mainly in the olfactory bulb region, nowhere pneumatizing the median areas of the roof, which are solid bone. The sinus extensions are dorso-lateral only. We have found a short one posteriorly, a long one anteriorly, and diverticula into the bases of the horns — except in the case of terminal horns: these are solid. In these titanothere skulls neither the attainment of giant size nor the development of gigantic superstructures stimulated pneumatization in the manner which in Recent mam-

mals is almost a matter of course. Today, a thick and massive cranial roof exists only in the Sirenia, an order which apparently at no time possessed frontal sinuses. The late titanotheres had this in common with the sirenians that their limb bones, too, were massive; there may have been a similar trend, counteracting the extension of pneumatization. Their cranium was, however, far larger than that of seacows, absolutely as well as in relation to the brain. Instead of enlarging in correspondence with its original and main function, that of being a brain capsule, this cranium enlarged in correlation with the general enlargement of the body — and the resulting discrepancies were, in the greater part of the cranium, not pneumatized. Only one ancient mammal seems to be known in which such a wide supra-cerebral space was pneumatic, and this was another titanothere, *Dolichorhinus* of the Upper Eocene. Only of one ancient mammal do we know hollow horns — the giant Lower Oligocene *Arsinoitherium*. Today, all bony horns are hollow. Up to 35 million years ago, this condition was exceptional.

During the search for cranial frontal sinuses it was incidentally observed that sinuses in the orbit walls may exist in a phyletic stage preceding the development of the frontal sinus proper. Orbital sinuses, consequently, can be independent developments; indeed they are the only dorsal sinuses in small living artiodactyls. Seen historically, they are not necessarily expansions of the cranial frontal sinus as which they appear in present-day topography of, for example, the horse skull. Further it was found that maxillary sinuses were in fact an early acquisition in mammaliam phylogeny, as their general occurrence and early Anlage in living forms had suggested. A maxillary sinus was present in the Eocene even in cetaceans, in whose later representative it is absent; and in the Equidae it was present in *Hyracotherium*, 30 million years before their frontal sinus developed.

It is, of course, foolhardy to draw general conclusions on the basis of data such as were available for the present study — e.g., a "series" consisting of three Oligocene, one Miocene and one Pliocene individual out of millions of fossil Canidae. The discovery (in great part on previously published specimens) of two fundamentally different evolutionary developments in two branches of the titanotheres has highlighted the fact that there is much material in our collections which has gone uninterpreted with regard to sinuses; further, as the condition in the titanothere giants may be either primary or secondary, the case exemplifies the fact that even a relatively well documented pneumatization story is open to several interpretations. I cannot, however, resist the temptation to describe a general picture of frontal sinus history which I gained from other authors' and my own observations.

Development of a frontal sinus relatively late in phylogeny has occurred in many phyla. Frontal sinuses were rare in the early Tertiary and only later became that characteristic of mammals which they are today. No frontal sinus was developed in Eocene and Oligocene representatives of orders in whose Recent genera the frontal bones are pneumatized. Bony horns were not in general pneumatic before the Miocene.

One has, of course, to consider the relation between the size of a skull and its pneumatization. We have seen one skull element, the brain capsule, not enlarging pari passu with phyletic enlargement of the head, and the same is true of at least two other elements, the capsules of eye and ear. Further, large superstructures of the head are in general peculiar to large forms. Thus discrepancies within the skull are bound to develop with phyletic size increase, and one reason for the increasing occurrence of frontal sinuses is certainly the fact that during the Tertiary body size increased in many phyla. This, however, is not the whole story. Discrepancies which are pneumatic in rhinoceros and elephant were not in general pneumatized in giant skulls of the early Tertiary; they were invaded by sinus diverticula only to a modest degree. Further, pneumatization is present today in similar-sized and smaller relatives of the early Tertiary forms in which it was absent.

The comparative rarity of frontal sinuses in the early Tertiary can be explained by, and is an evolutionary support of Weidenreich's theory of sinus origin. The early representatives of the surviving orders were more primitive than are the living genera. In the original mammalian condition, the skull components must have harmonized. There were no discrepancies between the brain chamber, the capsules of the sense organs, and the cranial surface — hence no room nor reason for frontal sinuses. The primitive mammal skull was designated to encase the sense organs as inherited from the Reptilia, and a brain which, with its portions serially arranged on one level, was not yet basically different in shape from the reptilian brain. This probably accounts for the fact that absence of frontal bone pneumatization can be added to the list of primitive characters in Mammalia. The early acquisition of maxillary sinuses is presumably related to the definitely un-reptilian masticatory apparatus of even the earliest mammals.

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## Explanation of Abbreviations

C., cerebral chamber
E., ethmoturbinals
O., olfactory bulb chamber
P., pit in sinus floor
S., frontal sinus
T., dorsal turbinal
f.m., fronto-maxillary opening
i.f., infraorbital foramen
n.c., nerve canals
or., orbit
p.f., postorbital foramen
se., septum sinuum frontalium
t., tentorium cerebelli

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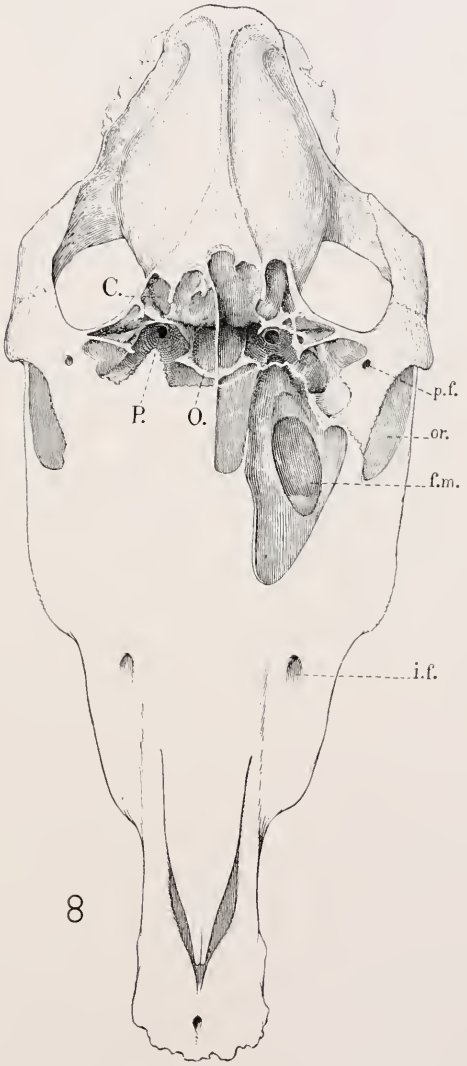
PLATES

PLATE 1

## PLATE 1

Fig. 8. *Equus caballus* (MCZ, Mammal Dept. 43500). Dorsal view of skull after removal of frontal sinus roof (supplemented, anterior to serrated line, after Sisson). x ¼.




8

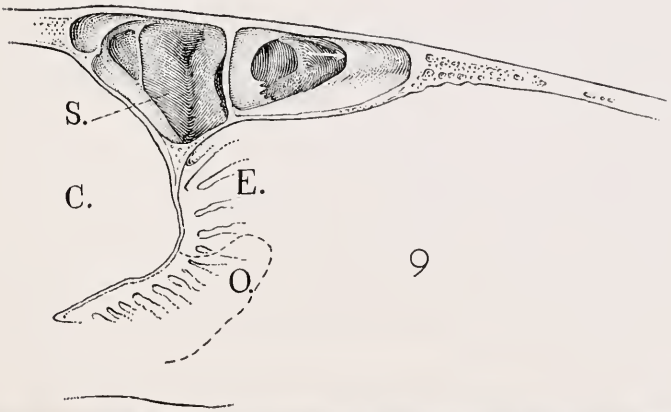
PLATE 2

## PLATE 2

Fig. 9. *Equus caballus* (MCZ, Mammal Dept. 1713). Frontal sinus region seen from midsagittal plane. x ½.

Fig. 10. *Hyracotherium venticolum* (AMNH 14810). Paramedian section of right frontal bone. x 5. (p. 420)

Fig. 11. The same. Transverse section of left (and median 2 mm. of right) frontal bone, 5 mm. behind anterior end of cerebral cavity. x 5. (p.420)

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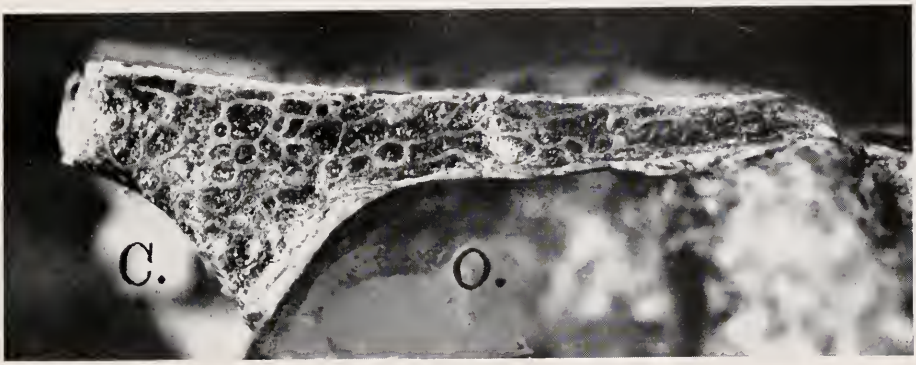


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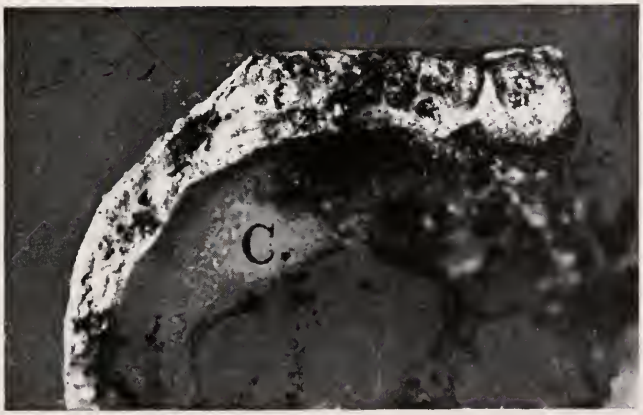


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PLATE 3

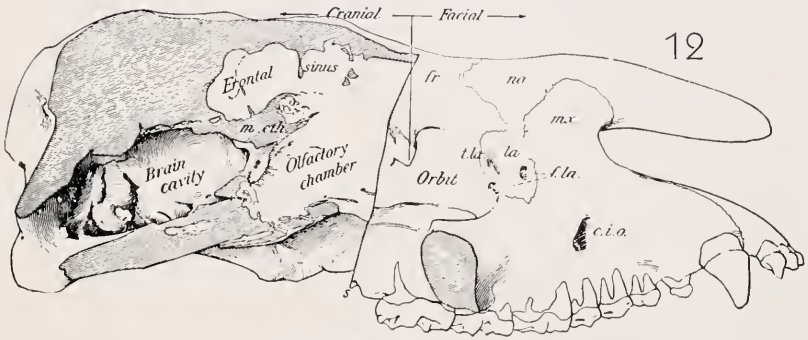
## PLATE 3

*Palaeosyops*
(from Osborn)

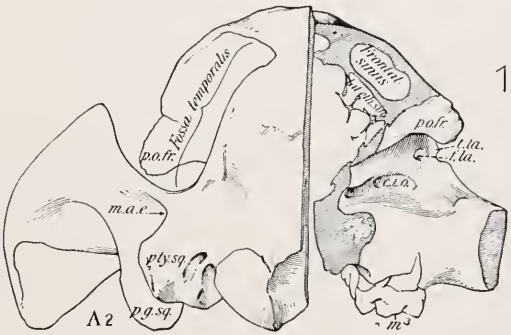
Fig. 12. *P. leidyi* (AMNH 1544). The skull in right side view, with the cranial region medially sectioned. x ¼. (p. 475)

Fig. 13. The same. Posterior view, with the right half sectioned at line "s" of fig. 12. x ¼. (p. 475)

Fig. 14. *P. robustus* (AMNH 1554). Junction of frontal (right side of figure) and nasal bones, vertically sectioned: "The region of the horn swelling"; added to Osborn's figure: arrows pointing to sinus roof. About nat. size. (p.458)


Cranial
Facial
Frontal sinus
Brain cavity
Olfactory chamber
m. eth.
fr
na
mx
Orbit
l.la.
la
f.la.
c.i.o.

12


Frontal sinus
p.o.fr.
Fossa temporalis
m.a.e.
pty.sq.
p.g.sq.
Λ2
m³

13

14

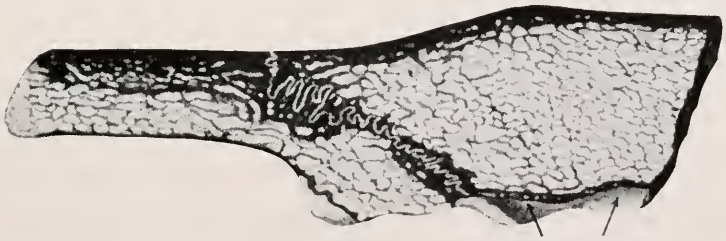
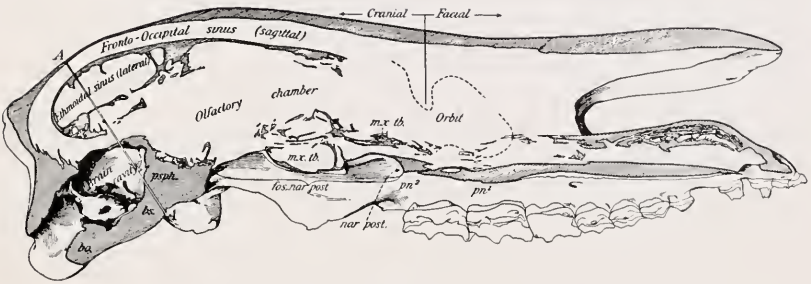


PLATE 4

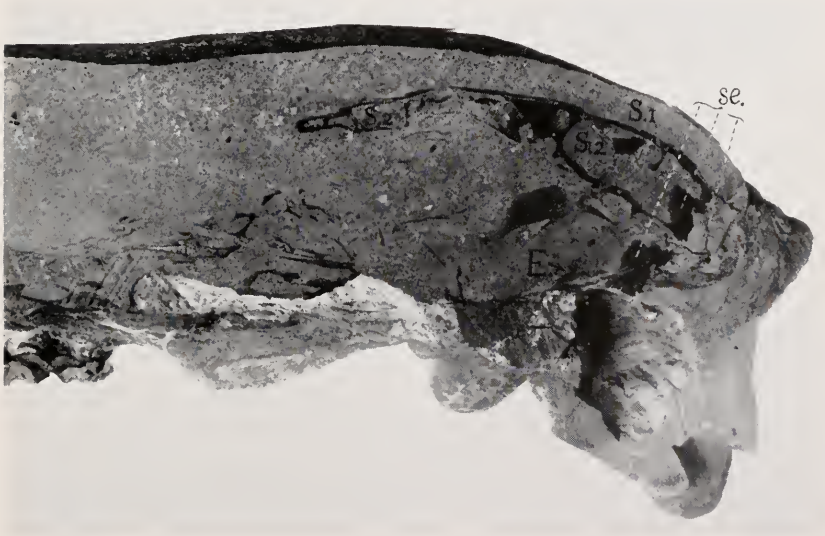
## PLATE 4

Fig. 15. *Dolichorhinus hyognathus* (AMNH 1851). Skull sectioned to the left of the midsagittal plane, left portion. From Osborn. x about 1/5. (p. 461)

Fig. 16. The same, right portion. AMNH photo. x about 1/3. (p. 461)


Cranial
Facial
Fronto-Occipital sinus (sagittal)
Ethmoidal sinus (lateral)
Olfactory chamber
m.x. th.
Orbit
m.x. th.
fos. nar post
pn²
pn¹
nar post.
bs.
ba.

15


S.2
S.1
S.2
se.
E

16

PLATE 5

## PLATE 5

Fig. 17. *Dolichorhinus longiceps?* (*hyognathus?*) (AMNH 1852). Cranium cross-sectioned somewhat posterior to line A-A of fig. 15; posterior portion. x 3/5. (p. 462)

Fig. 18. Titanotherium (MCZ 6226). Cranium cross-sectioned at posterior end of cerebellar chamber; posterior portion. x about 1/3. (p. 466)

17

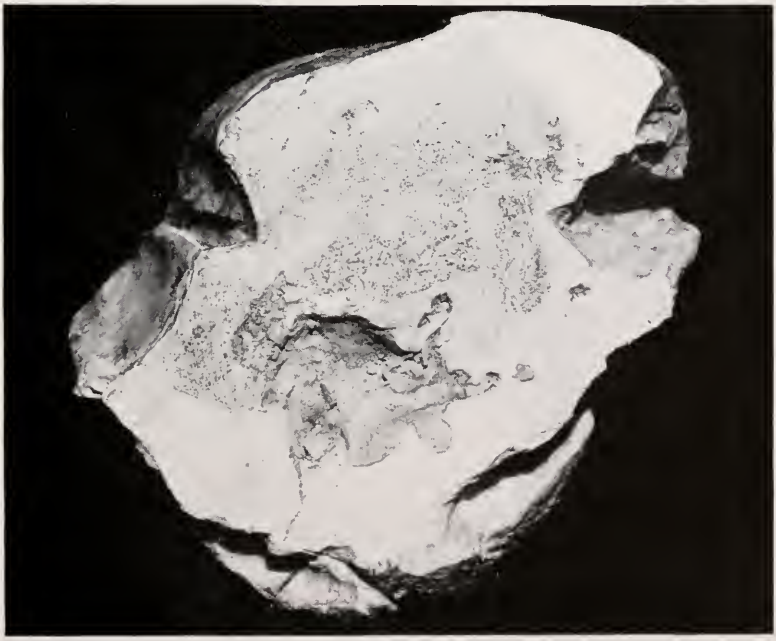


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PLATE 6

## PLATE 6

Fig. 19. Titanotherium (MCZ 6226). Cross section in anterior cerebral region; anterior view. x ¼. (p. 467)

Fig. 20. The same. Cross section between $M^3$ and $M^2$; posterior view. Inserted (broken line), from posterior surface of this section, the outline of $M^3$. x ½. (p. 469)

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PLATE 7

## PLATE 7

Fig. 21. *Brontotherium curtum* (MCZ 11698). Sectioned horn. x about 1/3. (p. 474)

Fig. 22. *Brontotherium platyceras* (MCZ 11214). Anterior end of nasal bones, posterior view. x 1/4. (p. 474)

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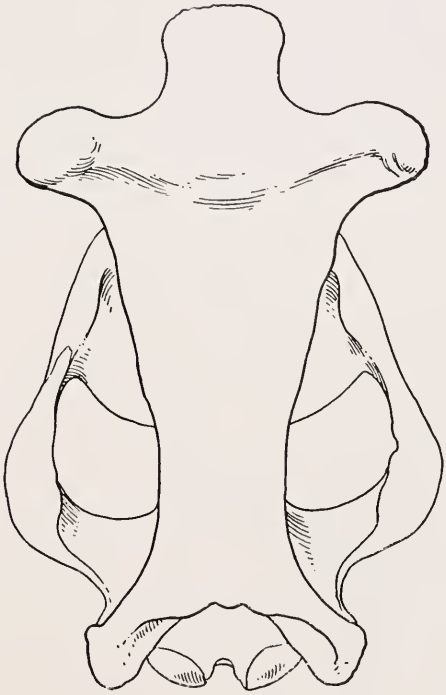
PLATE 8

## PLATE 8

Fig. 23. *Menodus giganteus.* Skull in dorsal view (from Osborn). x about 1/10. (p. 472)

Fig. 24. *Menodus proutii* (MCZ 6729). The shelf of coössified nasals, posterior view. x 1/2. (p. 473)



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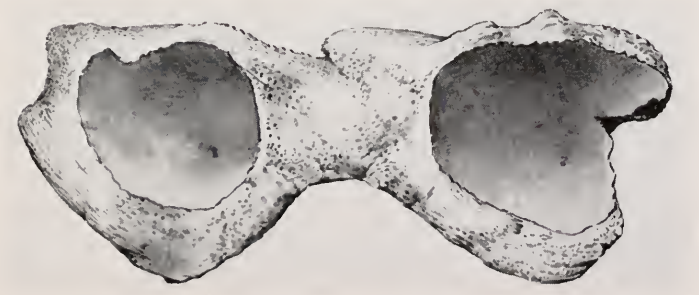

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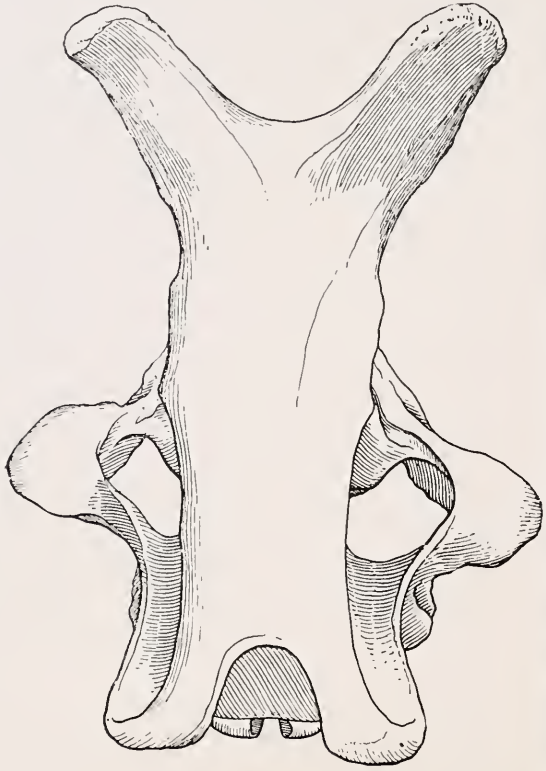
PLATE 9

## PLATE 9

Fig. 25. *Brontotherium platyceras* (AMNH 1448). Skull in dorsal view (from Osborn). Reduced. p. 475)

Fig. 26. *Bos taurus*. Skull in dorsal view, with the sinuses opened on the left side (from Sisson.) Reduced. (p.435, p.477)



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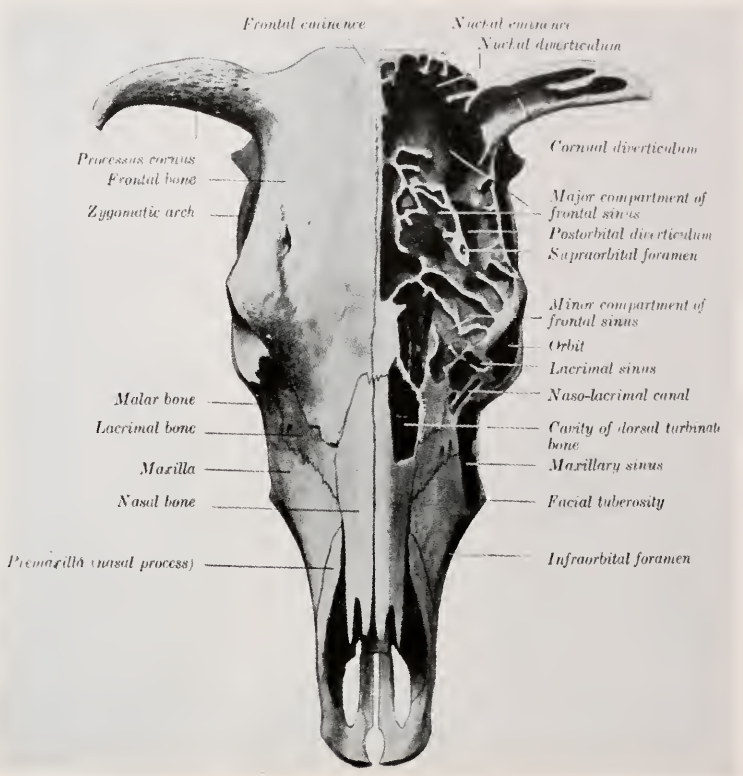
Frontal eminence
Nuchal eminence
Nuchal diverticulum
Processus cornus
Frontal bone
Zygomatic arch
Malar bone
Lacrimal bone
Maxilla
Nasal bone
Premaxilla (nasal process)
Cornual diverticulum
Major compartment of frontal sinus
Postorbital diverticulum
Supraorbital foramen
Minor compartment of frontal sinus
Orbit
Lacrimal sinus
Naso-lacrimal canal
Cavity of dorsal turbinate bone
Maxillary sinus
Facial tuberosity
Infraorbital foramen

26

7075
34

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